FOREST RESOURCES AND INDUSTRIES of ILLINOIS

By D. B. King and
R. K. Winters

A contribution of the Central States Forest Experiment Station, Forest Service, U. S. Department of Agriculture

Bulletin 562

UNIVERSITY OF ILLINOIS
AGRICULTURAL EXPERIMENT STATION

FOREST RESOURCES AND INDUSTRIES of ILLINOIS

By D. B. King and
R. K. Winters

A contribution of the Central States
Forest Experiment Station,
Forest Service, U. S. Department of
Agriculture

Bulletin 562
Agricultural Experiment Station · · UNIVERSITY OF ILLINOIS
Urbana, December, 1952

FOREWORD

This publication is one of a series of state reports resulting from the Nation-wide Forest Survey authorized by the McSweeney-McNary Forest Research Act of May 22, 1928. This particular report covers (1) Illinois' forest land and its timber supplies, (2) current timber growth on forested areas, (3) drain upon the forest through cutting for industrial and domestic uses and through fire, disease, and other causes, and (4) an interpretation and correlation of these findings with existing and anticipated economic conditions as an aid to those who formulate private and public policies regarding forest land management.

The Forest Survey of Illinois was made by the Central States Forest Experiment Station located at Columbus, Ohio, with the cooperation of the University of Illinois Agricultural Experiment Station and the Division of Forestry, Illinois Department of Conservation. This report was prepared in collaboration with Dr. J. Nelson Spaeth, Head of the Department of Forestry, University of Illinois, and Eino E. Nuuttila, State Forester, Division of Forestry, Illinois Department of Conservation. Special acknowledgment is also made to C. S. Walters and D. A. Kulp, Illinois Agricultural Experiment Station, for information regarding the production of veneer and mine timbers; to the Forest Products Laboratory, Madison, Wisconsin, for assistance in log-grade studies; and to R. W. Olson, former Forest Supervisor of the Shawnee National Forest, to E. N. Lee, present supervisor, and to R. D. Lane, in charge, Carbondale Research Center of the Central States Forest Experiment Station, for helpful advice and suggestions in manuscript review.

This report is published by the University of Illinois Agricultural Experiment Station under a cooperative agreement with the Forest Service, U. S. Department of Agriculture.

Forest Survey Staff
Central States Forest Experiment Station

R. K. Winters, *Chief, Division of Forest Economics*
E. V. Roberts, *In Charge, Forest Survey*

Staff Assignments

Photographic interpretation	K. E. Moessner
Field inventory	M. E. Becker
Industrial drain	M. E. Becker, J. T. Morgan
Mensurational analyses	G. L. Schnur
Computations and tabulations	L. F. Compton
Forest resource analysis	D. B. King

Photo Interpreters

O. K. Hutchison K. L. Quigley

Inventory Field Men

D. A. Bernstein	J. L. Burkle	E. P. Van Arsdel
A. E. Block	T. J. Schmitt	J. E. Wiggins

ILLINOIS FORESTRY FACTS

1. Land area of Illinois: 35.8 million acres
2. Original forest area: 14 million acres (39 percent of total land area)
3. Present forest area: 4 million acres (11 percent of total land area)
   Commercial forest area: 3.9 million acres
   Noncommercial forest area: 0.1 million acres
4. Location of commercial forest area
   Prairie region: 1.6 million acres (7 percent of regional land area)
   Claypan region: 1.3 million acres (16 percent of regional land area)
   Southern region: 1.0 million acres (26 percent of regional land area)
5. Ownership of commercial forest land
   Private: 3.75 million acres (95.2 percent)
   Federal: 0.18 million acres (4.5 percent)
   State: 0.01 million acres (0.3 percent)
6. Net volume of saw-timber growing stock, 1948
   Total volume: 10,258 million board feet
   Total volume of high-quality (grade 1 and 2 logs): 2,412 million board feet
   Average volume per acre: 2,603 board feet
7. Net volume of total growing stock, 1948
   Total volume: 2,372 million cubic feet (36 million cords)
   Average volume per acre: 602 cubic feet (9 cords)
8. Annual net growth of saw-timber growing stock, 1947
   Total volume: 397 million board feet (4.0 percent of inventory volume)
   Average volume per acre: 101 board feet
9. Annual net growth of total growing stock, 1947
   Total volume: 90.7 million cubic feet (3.9 percent of inventory volume)
   Average volume per acre: 23.0 cubic feet
10. Harvest of primary forest products, 1947: 52.4 million cubic feet
11. Value of primary forest products, 1947: 12 million dollars
12. Illinois labor used in harvesting and processing forest products, 1947: 46,000 man-years (250 days per year)
13. Cutting drain on saw-timber growing stock, 1947: 163 million board feet
14. Cutting drain on total growing stock, 1947: 38.4 million cubic feet
15. Annual change in inventory volume, 1947
    Saw-timber growing stock: increase of 234 million board feet (2.3 percent)
    Total growing stock: increase of 52 million cubic feet (2.3 percent)

CONTENTS

PAGE

GENERAL DESCRIPTION OF STATE 5
Physical Characteristics 5
Topography 5
Climate 6
Physiographic regions 7
Economic and Social Characteristics 10
Land Use 11
Potential forest land 13
Values obtained from forest land . 14
Grazing destroys woodland values 18
THE FOREST RESOURCE 19
Forest Area 20
Acreage 20
Ownership 23
Forest types 24
Stand-size classes 29
Stocking 31
Site quality 33
Timber Volume 34
Board-foot volume 34
Cubic-foot volume 42
Timber Growth 46
FOREST-PRODUCTS INDUSTRIES . . 50
Primary Forest-Products Industries 51
Lumber 53
Fuelwood 57
Cooperage stock 58
Fence posts 59
Pulpwood 59
Veneer 60
Mine timbers 61
Miscellaneous products 62

PAGE

Secondary Forest-Products Industries 63
Cutting Drain on the Forest Growing Stock 64
Drain on the saw-timber growing stock 64
Drain on the total growing stock . . 65
Drain by log grade 66
TRENDS IN TIMBER VOLUME AND STAND COMPOSITION 67
Current Growth-Drain Balance . . . 67
Past Growth-Drain Balance 69
Future Growth-Drain Balance 70
A PROGRAM TO INCREASE RETURNS FROM FOREST LANDS 72
Protect the Forest 73
Build Up the Timber Stand 75
Improve Marketing and Utilization 78
Intensify Research 82
SUMMARY 83
APPENDIX 88
Forest Survey Procedure 88
Accuracy of Data 91
Definitions of Terms Used 91
Species Listed 95

Publications in the Bulletin series report the results of investigations made by or sponsored by the Experiment Station

FOREST RESOURCES AND INDUSTRIES OF ILLINOIS

By D. B. King and R. K. Winters

GENERAL DESCRIPTION OF THE STATE

Physical Characteristics

ILLINOIS is located south of the Great Lakes near the center of the great midwestern corn belt. The state extends 385 miles from north to south, approximately one-third of the distance between the Canadian border and the Gulf of Mexico. From east to west its extreme breadth is about 218 miles. Total area is roughly 56,400 square miles, of which 453 square miles is water. With 35.8 million acres of land area, Illinois ranks twenty-third in size among the states.

Nearly three-fourths of the total length of the state's boundaries are navigable rivers — the Mississippi on the west, the Ohio on the south, and the Wabash on the east. The northeastern boundary includes 65 miles of the Lake Michigan shore line.

Topography

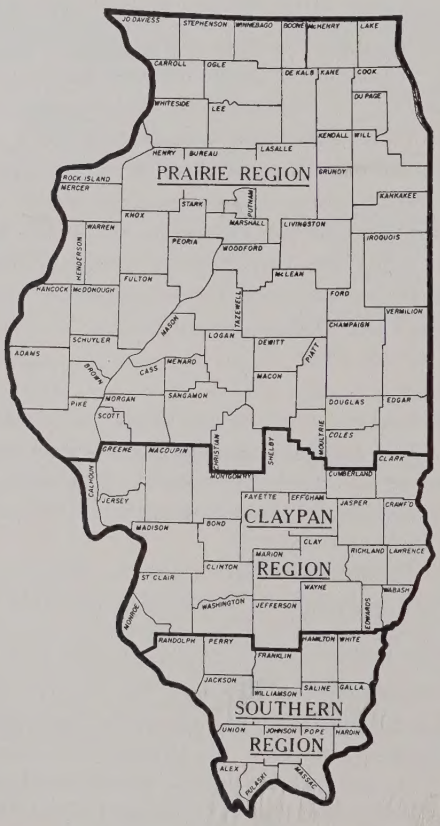
Illinois, generally known as the "Prairie State," is one of the most level of the states. This levelness, largely due to glaciation, was a major factor influencing the rapid development of the state; it facilitated the construction of an excellent transportation system and the use of labor-saving farm machinery.

Although most of the area of Illinois is level to slightly undulating, the general uniformity is broken by occasional bluffs and the rough breaks along the principal rivers and their tributaries, by glacial moraines in the northeast, and by rough unglaciated areas in the southern and extreme northwestern parts of the state. The highest point, 1,241 feet above sea level, is Charles Mound in the unglaciated northwestern corner adjoining Wisconsin and Iowa. The lowest point, about 270 feet above sea level, is at the junction of the Ohio and Mississippi rivers in Alexander county. Average elevation of the state is about 550 feet.

Climate

Because of its latitude and inland location, Illinois has extremes of temperature. Summers are generally hot and winters, cold. The highest temperature ever recorded was 115 F. at Greenville in 1936 and the lowest, −35 F., at Mount Carroll in 1930. The average frost-free period varies from about 150 days in the north to about 213 days in the extreme south.

Average annual precipitation ranges from approximately 31 inches in the north to more than 47 inches in the south. In the north most of the rainfall occurs during the growing season. Although short drouths



Physiographic regions of Illinois. (Fig. 1)

occasionally reduce crop yields and increase fire hazard in the woodlands, both the volume and distribution of precipitation are generally dependable. The annual snowfall averages about 22 inches and varies uniformly from more than 35 inches in the northwest to less than 10 inches in the extreme south. Wet weather often curtails logging operations during the winter months, especially in the southern part of the state.

Physiographic regions

Differences in physiographic conditions cause local variations in forest conditions and forest problems. To facilitate interpretation of Forest Survey data in the light of these differences, the state was divided into three broad physiographic regions (Fig. 1): (1) the Prairie region, which includes the northern two-thirds of the state, (2) the Claypan region, which extends across the state from east to west, south of the center, and (3) the Southern region, which includes the 16 southernmost counties. The actual boundaries of these physiographic regions are seldom sharply defined because the transition from one to another is usually gradual. Since forest statistics could best be gathered by counties, the regional boundaries used in the Forest Survey were drawn on county lines that only roughly conform to the actual physiographic boundaries.

The Prairie region. Although this region is a highly developed agricultural area — the center of the fertile midwestern corn belt — it contains 1.6 million acres of forest land found chiefly in small farm woodlands generally located on rough or poorly drained areas (Fig. 2). Except for the rough breaks along the major streams, the rolling unglaciated area in northwestern Illinois, and occasional moraines scattered throughout the eastern half of the region, most of the land is nearly level to gently sloping. The fertile soils which characterize most of this region developed from loess or glacial drift which was not strongly weathered. Most of these soils developed under prairie grasses. Soils which developed under hardwood forest occur over fairly extensive areas near the northern border of the state and along the Illinois and Mississippi rivers and their tributaries in western Illinois. Today approximately 7 percent of the land is forested with stands of mixed oaks, elm, soft maple, hickory, and other hardwood species as well as a relatively small volume of redcedar.

The Claypan region. Over one-fifth of the state lies in the Claypan region. Most of this region is nearly level to gently sloping except for

Woodlands in the Prairie region of Illinois total 1.6 million acres and are generally located on the rough breaks and poorly drained bottomlands along the streams. (Fig. 2)

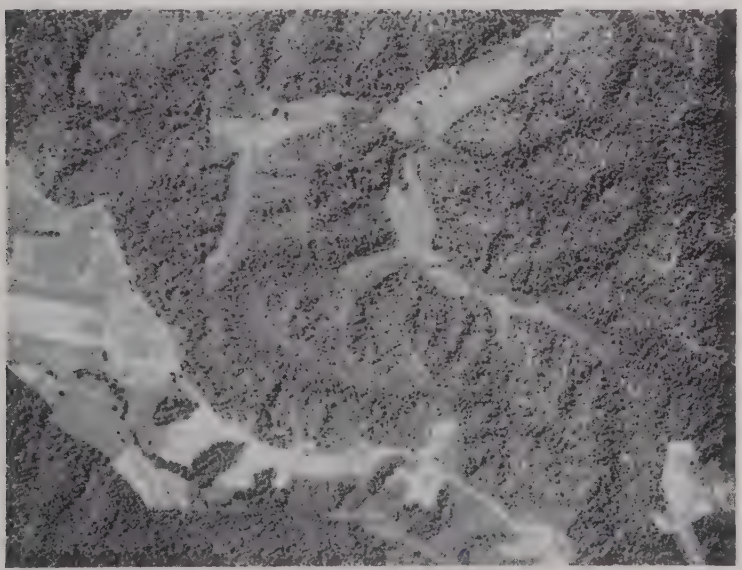
steep areas of limited extent along some of the streams. The soils are low to medium in productivity and have relatively impermeable subsoils that restrict subsurface drainage. Most of the soils developed from loess over strongly weathered Illinoian glacial till. The blanket of loess is 2 to 4 feet thick over most of the region except in the western part, where it is thicker. The soils on the upland flats, roughly 40 percent of the entire region, developed under prairie grasses. On the slopes and better-drained areas the soils developed under hardwood forests.

At present 1.4 million acres, 16 percent of the land area in this region, is forested with stands of mixed oaks, elm, hickory, soft maple, ash, and other hardwoods. The timber stands occur largely on the rough breaks and bottomlands along the rivers and in thousands of small farm woodlands scattered throughout the region.

The Southern region. The most distinctive physiographic features of the Southern region are the range of hills in the Ozark ridge and the bottomlands adjoining the Mississippi, Ohio, and Wabash rivers and their tributaries.

The Ozark ridge in southern Illinois, an extension of the Ozark highlands of Missouri and Arkansas, is the most extensively forested area in the state (Fig. 3). This ridge of hills extends across the state through Union, Johnson, Pope, and Hardin counties and the adjoining counties to the north. It extends 70 miles from east to west and averages about 12 miles from north to south. The ridge rises to more than 700 feet in several areas and in eastern Pope county reaches a maximum altitude of 1,065 feet, more than 700 feet above the Ohio river, which lies 12 miles to the south. A mantle of loess covers the unglaciated Ozark uplift except where erosion has removed the loess, leaving residuum or bedrock exposed. The soils throughout this area developed under hardwood forests.

The soils of the level bottomlands were derived from material deposited by the rivers. They are, therefore, of complex origin and differ markedly in age and physical properties. Some bottomlands, particularly those along medium-sized streams which flow from the strongly weathered Illinoian till plain, are composed of clay and are relatively unproductive. Other bottomlands, especially along the Mississippi,



The most extensive forests in the state cover the Ozark hills in the Southern region, where cultivated crops are largely confined to the valleys. (Fig. 3)

Ohio, and Wabash rivers, are composed of recent alluvium which is very fertile. Practically all of the bottomland soils originally supported hardwood forests. Although most of the bottomlands in this region are now under cultivation, the poorly drained, less fertile, and most frequently flooded areas still support forests which total almost 300,000 acres.

The entire Southern region includes almost 4 million acres, 11 percent of the total land area of the state. The forest area in this region totals more than 1 million acres, 26 percent of the land area, and supports timber stands consisting primarily of mixed oaks, hickory, elm, sweetgum, soft maple, cottonwood, and other hardwoods, as well as relatively insignificant volumes of cypress and redcedar.

Economic and Social Characteristics

The first white settlers in Illinois were French Canadians who, about 1700, established the settlements of Cahokia and Kaskaskia on the Mississippi between the mouths of the Missouri and Ohio rivers. During the following century settlement progressed very slowly. The entire white population of this territory in 1800 was estimated to be less than 2,500. Then began a century of rapid settlement and development accelerated by the government's liberal land disposal policies, the development of laborsaving farm equipment, and improvements in transportation facilities. The latter were highlighted by the opening of the Erie canal and the development of water transportation on the Great Lakes, the construction of the Illinois and Michigan canal, and finally the establishment of an excellent railroad system.

In 1950 Illinois had a population of 8.7 million (about three-fourths of it urban), ranking fourth in the nation behind New York, Pennsylvania, and California. Manufacturing is the predominant activity of the labor force. During 1947 at least 46,000 man-years of Illinois labor, or 1 to 2 percent of the total labor force, were expended in harvesting and processing forest products.

According to the U. S. Bureau of Agricultural Economics, Illinois ranks fourth in the nation and first among the states east of the Mississippi river in cash receipts from farming. In 1947 these receipts amounted to more than 1.9 billion dollars.

Farmers are estimated to own about 90 percent of all Illinois forest land. According to the 1950 Census of Agriculture, nearly 45 percent of all farms have woodlands, averaging about 35 acres per farm. The value of all logs and bolts harvested from Illinois farm woodlands

during 1947 is conservatively estimated at 10 to 11 million dollars, f.o.b. local delivery point. This indicates an average of about $160 per farm for all farms with woodlands. Since more farmers are beginning to recognize timber as a profitable crop and to adopt better forest-management practices, the contributions of the farm woodland to the farm economy will no doubt increase. Farmers are receiving assistance in managing their woodlands from the State Extension Foresters and from the farm foresters jointly sponsored by the state and federal governments under the Cooperative Forest Management Act of 1950. The growing interest in farm woodlands is demonstrated by the increasing number of requests received from farmers for technical aid in woodland management.

The coal and oil industries in the southeastern part of the state exert a considerable influence on the local primary forest-products industries. In many of these areas the timber operators must compete for labor with the higher-paying coal and oil industries. The resulting labor costs often place the mill operators in these areas at a disadvantage in competition with mills elsewhere in the state and in other states. Largely because of local labor costs, lumber often is imported from distant mills at a lower cost than it can be bought locally.

For example, the coal mines, one of the major markets in the state for forest products, import a large proportion of their wood requirements from surrounding states, particularly Missouri. Roughly two-thirds of the estimated 6 million cubic feet of round timbers used by Illinois mines in 1947 were shipped in from other states, as was about one-third of the 30 to 40 million board feet of sawn products used. Since 1947, however, the proportion of local wood used has been increasing.

The Illinois forest resource is now capable of supplying all hardwood timber requirements of the local coal mines. The markets for local timber could be expanded substantially by substituting Illinois timber for that now being shipped in from other states for use in Illinois coal mines.

Land Use

Most of the land in Illinois is, and probably always will be, used for agriculture. At present more than 75 percent of all land in the state is used either for crops or as open pasture, as compared with 11 percent in forest.

The land-use pattern differs considerably among regions. The

Prairie region is the most prosperous agricultural region in the state. According to Census estimates of the value of farm products sold or used by farm households during 1944, the Prairie region produces about 80 percent of the farm output of the entire state. As already mentioned, forests occupy only 7 percent of this region, as compared with 16 and 26 percent, respectively, in the Claypan and Southern regions.

In all regions the proportion of land in forest is constantly shifting as a result of changes in land-use practices. Woodlands are constantly being cleared by overgrazing and cutting. On the other hand, land clearing is offset by the return of open fields to forest through forest planting and through the natural encroachment of forest cover on submarginal agricultural areas that have been abandoned (Fig. 4). During the past decade the net effect of these movements from open field to forest and from forest to field has been an approximate balance. Survey measurements of these changes in land use during the 8-year period between the date of aerial photographs and date of field examination (page 88) indicate that the forest area was reduced 1 percent. Land clearing is most prevalent in the agricultural Prairie region, where the forest area was reduced 7 percent during the 8 years. In the southern two regions, land abandonment has outweighed land clearing, and the forest area was increased about 3 percent during the same period.

Sassafras and persimmmon invade an old field. This is the first step in natural plant succession from open field to forest. (Fig. 4)

These trends probably will continue during the immediate future. The forest area in the Prairie region will likely continue to get smaller because of agricultural competition, especially grazing pressure. In the southern two regions the forest area will probably increase as additional submarginal agricultural areas are abandoned. However, if each specific area were to be dedicated to the use for which it is best suited under a sound land-use program, the forest area in every region would be increased substantially.

Potential forest land

The future prosperity of the state depends to a large extent upon wise land use. To develop a sound land-use program, all lands first need to be classified as to best use. The productivity ratings of soil types established by the Illinois Soil Survey provide a means of estimating the acreage of potential forest land in Illinois — that is, the marginal and submarginal crop and pasture land that might be best used for growing timber. According to recent compilations of the Department of Forestry, Illinois Agricultural Experiment Station, areas of lowest soil productivity in a scale of ten, which include soil types such as the Cahokia silt loam, the Hickory and Hennepin gravelly loams, limestone outcrops, and rough, stony areas, represent more than 4 million acres of potential forest land. Much of the area rated next to the lowest in soil productivity is also considered potential forest land. The soil types included in this classification total roughly 2 million acres and include the Cisne, Wynoose, Rinard, and Bluford silt loams found primarily in the Claypan regions, and the Plainfield sands of central and northern Illinois. Of course, much of the present forest area is on these soil types.

In addition to these areas of low soil productivity, a large acreage of more productive soils on the untilled bottomlands and on steep slopes should be devoted to timber growing. A permanent forest cover could halt the severe gullying and erosion that are destroying the fertility and usefulness of many cleared slopes (Fig. 5). The future forest will also include areas of relatively productive soils suitable for cultivation which are now in forest and will be kept in forest because the owners choose to do so.

Although the foregoing indicates that more than 6 million acres probably should be in forest, the area that actually will be devoted to forest cannot, of course, be predicted. This depends on several variable factors such as future land-use competition, changes in general economic conditions, the intensity of land management proposed, and

Severe gullying and erosion are destroying the fertility and usefulness of many cleared slopes such as this one. A permanent forest cover is the answer to the problem. (*Courtesy Division of Forestry, Illinois Department of Conservation.*) (Fig. 5)

desires of the owner. It seems likely, however, that under a reasonably intensive land-use program the forest area will increase substantially.

Values obtained from forest land

The forest land can benefit the state most if it is managed for watershed protection, recreation, and wildlife propagation as well as for timber production. In some areas the influence of the forest on stream flow, water supplies, and erosion is more important than timber production. The recreational value of forest land along a lake shore or near a large city may be much greater than the value of the timber it can produce. On the other hand, timber can often be harvested from forest lands managed primarily for recreational use.

To manage a forest property for maximum returns, all kinds of uses should be considered and multiple use should be made of the area where practicable. In this section, only watershed protection and recreational and wildlife values will be discussed, while timber production will be discussed in later sections.

Watershed protection. Much of the Illinois land classified as best suited to forest use occurs on rough areas with steep slopes that are subject to severe soil erosion when mismanaged. Through good forest management these areas can be made to contribute maximum watershed protection and still yield timber products.

In the upper picture is an extreme example of erosion in Jackson county in the Southern region of Illinois. The lower picture shows the same area one year after black locust trees were planted. (Fig. 6)

The ground surface under a well-managed forest is generally covered by a porous layer of humus with a protective layer of leaf litter. The soil is granular and spongy with high infiltration rates and water-holding capacities. Soil moisture is usually favorable for earthworms and burrowing insects which, together with the network of tree roots, form numerous small air passages which further improve the porosity of the soil. The ability of such soils to absorb water reduces the damaging surface flow and so reduces erosion and stream sedimentation, increases the recharge rate of the ground water supply, and helps to stabilize the flow of the streams.

The establishment of a forest cover can halt erosion on severely gullied lands and on areas too steep to be controlled by other types of vegetation (Figs. 5 and 6). Increased watershed protection can be obtained from areas now under forest cover through improved cutting and logging, the elimination of grazing, and intensified fire control.

The solution of Illinois' stream-flow, flood, and erosion problems depends largely on proper management of all lands within the basins of Illinois streams, including lands in other states as well as Illinois.

Recreation and wildlife. Recreation is definitely an important form of forest land use, especially in heavily populated states such as Illi-

Illinois people enjoy woods and water. Public forest areas near large cities are especially valuable for recreation. (Fig. 7)

nois (Fig. 7). The demand created by city dwellers for outdoor recreation is greater today than ever before. Each year thousands of Illinois residents take vacation trips to Minnesota, Wisconsin, and Michigan. Although these northern states and other, more distant areas will continue to draw a large number of Illinois tourists, the growing demand by citizens of the state for recreational facilities suitable for short vacations and week-end trips could be largely met within the state.

Illinois has hills, streams, forests, lakes, scenic outlooks, and many historical points of interest that could be developed to attract tourists. Potential picnicking, hiking and camping sites are easily accessible to most cities. The 11,500 miles of streams and the 57,600 acres of glacial and artificial lakes in the state are stocked with about 30 species of fish that provide sport for well over a half million licensed anglers each year.

The forests contain numerous species of game and furbearing animals. Most abundant of the game species are the squirrels, the cottontail rabbit, and the bobwhite quail. Nineteen species of ducks and three of geese are hunted in Illinois, primarily along the Mississippi flyway and on the bottomland lakes in the Southern region. One outstanding attraction for hunters throughout the Midwest is the great concentration, 75,000 or more, of geese that winter in and around the Horseshoe Lake Wildlife Refuge in Alexander county. Many furbearing animals are harvested annually. According to the Illinois Natural History Survey, about 30,000 trappers operated in the state during the 1947-48 season. The pelts taken that year included fox, mink, muskrat, opossum, raccoon, skunk, and weasel, and were valued at more than 2 million dollars.

Although some forests, especially county forests, have been developed, Illinois has not taken full advantage of the recreational opportunities provided by the forest land. Besides the many intangible returns to the people, such as relaxation, health, and enjoyment, recreational development can contribute handsomely in cash, jobs, and economic prosperity. Many states have recognized the possibilities offered by the tourist trade and have undertaken ambitious recreational development programs. In some states, such as California, Florida, and the northern Lake States, recreation is considered one of the leading industries. The tourist trade will probably never be that important in Illinois, for climate is less favorable, forests are less extensive, and there are fewer lakes and streams suitable for resort development. However, Illinois can develop its relatively unused recreational resources to provide greatly increased benefits, both economic and esthetic, for the people of the state.

Forest restoration, wildlife propagation, and recreational development are closely allied. As the forests are improved and restored under a more intensive land-management program, recreational values will increase. Through expanded recreational use, the Illinois forest land can be made to contribute far more than at present to the physical and economic welfare of the people.

Grazing destroys woodland values

Much of the Illinois forest land is grazed. According to the 1950 Census of Agriculture, grazing is permitted on two-thirds of the farm woodland area in the state. Forest Survey estimates indicate that almost one-third of all the forest land is so heavily grazed that if the same degree of grazing is continued, the forest cover will eventually be eliminated by the continuous destruction of all tree reproduction. Woodland grazing is most prevalent in the Prairie region, where 42 percent of the forest land is heavily grazed. Heavy grazing is prac-

On the right-hand side of the fence, grazing has been permitted; on the left-hand side, there has been no grazing. Note the lack of tree reproduction in the grazed area. (Fig. 8)

ticed on 22 percent of the forest land in the Claypan region, and on 18 percent in the Southern region.

The degree of woodland grazing has a pronounced effect on the stocking. In the state as a whole, 59 percent of the forest area with poor tree stocking is heavily grazed. In contrast only 12 percent of the forest area having good tree stocking, and 36 percent with fair stocking, is heavily grazed. In the Prairie region 73 percent of the woodland area with poor tree stocking is heavily grazed.

In the small farm woodlands of Illinois, grazing is incompatible with timber production. As generally practiced at present, grazing results in (1) the failure of tree reproduction (Fig. 8), (2) decreased growth and increased cull in the surviving trees, (3) exposure and injury to tree roots, (4) compaction of the soil, and (5) the destruction of ground litter and humus. The degree of damage obviously depends on the intensity of grazing. Especially in the Prairie region, the damage to forest cover caused by overgrazing probably is greater than that caused by any other destructive agency.

Maximum forest productivity can never be reached in Illinois until the livestock are eliminated from the woodlands that are devoted to timber production.

THE FOREST RESOURCE

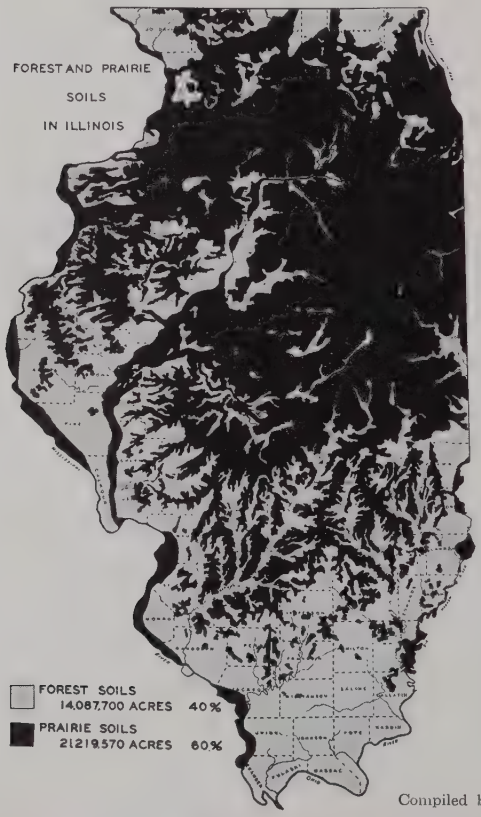
The forest resource statistics that follow differ from those compiled by the Forest Service, U. S. Department of Agriculture, in its 1945 reappraisal of the forest situation in the United States. These previous estimates were based upon the best information available locally at the time. The Forest Survey statistics, on the other hand, are based on a scientifically designed sampling procedure involving both aerial photographs and ground plots (page 88), and provide statistically reliable data on a state-wide basis.

The three-year period between the reappraisal and the Forest Survey is too short to have any substantial influence on the difference between the two estimates. Under the current favorable growth-drain relationship, the saw timber is being built up at the rate of about 2 percent per year. Although this increase is substantial, it does not nearly account for the differences in the two estimates.

Forest Area

Acreage

Although the exact acreage of the original timber stand in Illinois cannot be determined, the area of soils known to have developed under forest cover indicates that the timber stand once extended over more than 14 million acres or about 40 percent of the state (Fig. 9). During the two and a half centuries since the first white settlement, practically all the virgin timber in Illinois has been cut and about three-fourths of the original forest area cleared.



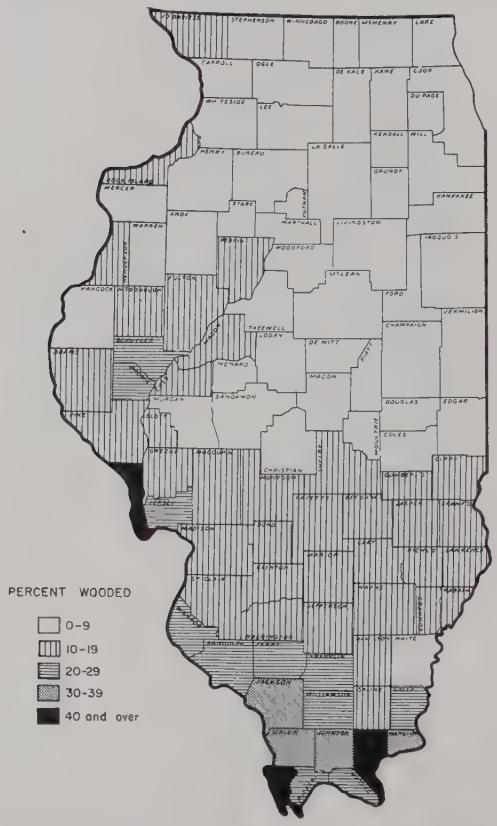
Forest and prairie soils in Illinois. Today only about one-fourth of the original forest area is in timber. **(Fig. 9)**

Table 1. — Total Land and Forest Area in Illinois, by Physiographic Region and County, 1948

County	Total land area, 1,000 acres	Forest area		County	Total land area, 1,000 acres	Forest area	
		1,000 acres	Pct. of total area			1,000 acres	Pct. of total area
Prairie region							
Adams	554	93	17	Livingston	668	9	1
Boone	181	6	3	Logan	398	11	3
Brown	196	42	21	McDonough	372	40	11
Bureau	555	35	6	McHenry	391	16	4
Carroll	300	22	7	McLean	751	18	2
Cass	237	46	19	Macon	369	12	3
Champaign	640	7	1	Marshall	253	28	11
Christian	454	13	3	Mason	346	44	13
Coles	324	23	7	Menard	200	15	8
Cook	611	30	5	Mercer	356	28	8
DeKalb	407	5	1	Morgan	362	30	8
DeWitt	255	11	4	Moultrie	221	8	4
Douglas	269	5	2	Ogle	484	29	6
DuPage	212	11	5	Peoria	399	52	13
Edgar	402	23	6	Piatt	280	7	2
Ford	312	1	0	Pike	530	97	18
Fulton	559	96	17	Putnam	106	18	17
Grundy	276	10	4	Rock Island	269	34	13
Hancock	510	46	9	Sangamon	563	24	4
Henderson	244	35	14	Schuyler	278	69	25
Henry	529	17	3	Scott	161	21	13
Iroquois	718	13	2	Stark	186	6	3
Jo Daviess	393	60	15	Stephenson	363	16	4
Kane	330	10	3	Tazewell	418	38	9
Kankakee	435	16	4	Vermilion	575	29	5
Kendall	205	8	4	Warren	347	25	7
Knox	466	44	9	Whiteside	442	16	4
Lake	292	20	7	Will	541	23	4
LaSalle	738	26	4	Winnebago	333	22	7
Lee	467	9	2	Woodford	344	30	9
Total					23,377	1,598	7
Claypan region							
Bond	245	37	15	Jersey	239	66	28
Calhoun	166	72	43	Lawrence	239	34	14
Clark	323	58	18	Macoupin	558	95	17
Clay	297	46	15	Madison	468	57	12
Clinton	319	62	19	Marion	371	62	17
Crawford	283	40	14	Monroe	243	58	24
Cumberland	222	30	14	Montgomery	452	46	10
Edwards	144	20	14	Richland	233	30	13
Effingham	309	47	15	St. Clair	429	55	13
Fayette	460	84	18	Shelby	494	55	11
Greene	348	54	16	Wabash	141	14	10
Jasper	317	36	11	Washington	362	63	17
Jefferson	367	61	17	Wayne	458	74	16
Total					8,487	1,356	16
Southern region							
Alexander	143	67	47	Perry	283	61	22
Franklin	278	62	22	Pope	244	100	41
Gallatin	210	55	26	Pulaski	131	34	26
Hamilton	278	53	19	Randolph	380	85	22
Hardin	117	45	38	Saline	246	43	18
Jackson	386	123	32	Union	265	101	38
Johnson	221	79	36	White	321	30	9
Massac	157	44	28	Williamson	282	60	21
Total					3,942	1,042	26
Total for state					35,806	3,996	11

Today the area of forest land in Illinois totals about 4 million acres, 11 percent of the total land area (Table 1). Additional wooded areas in narrow strips and areas of less than 1 acre, which are not considered forest land, total roughly 300,000 acres. The most extensive forests in the state are located on the Ozark hills in the southern counties (Fig. 10) and on the rough breaks and the bottomlands of the major streams. Smaller tracts of forest land are scattered throughout the rest of the state in thousands of farm woodlands.

All except 55,000 acres of the forest land is classified as commer-



Proportion of land area in forest in each Illinois county, 1948. (Fig. 10)

Table 2. — Land Area by Major Use and Physiographic Region, 1948

Land use	State		Prairie	Claypan	Southern
	thousand acres	*percent*	*thousand acres*		
Forest:					
Commercial	3,941	11.0	1,564	1,347	1,030
Noncommercial:					
Withdrawn from timber use	46	.2	34	9	3
Nonproductive site	9	(a)	0	0	9
Total	**3,996**	**11.2**	**1,598**	**1,356**	**1,042**
Nonforest	31,810	88.8	21,779	7,131	2,900
Total	**35,806**	....	**23,377**	**8,487**	**3,942**
Percent of total area	.....	*100.0*	*65.3*	*23.7*	*11.0*

(a) Less than .05 percent.

cial forest land (Table 2). About 46,000 acres have been withdrawn from commercial timber production for other uses, primarily for recreational areas, wildlife refuges, and the protection of reservoir watersheds. Another 9,000 acres in the Southern region is composed of unproductive areas such as exposed rock faces and ridges which are not capable of producing trees that will average one 8-foot merchantable log. Since the noncommercial forest area is small and occurs in scattered tracts, it has little or no effect on the over-all forest situation.

Ownership

Private holdings total almost 3.8 million acres, 95 percent of the commercial forest land in the state (Table 3). Practically all of the private commercial forest land is owned by farmers (page 10). According to recent estimates of the Forest Service, U. S. Department of Agriculture, all privately owned commercial forest land in Illinois is in holdings of less than 5,000 acres each. It is apparent that the future of the state's timber resource depends largely on the management given the small privately owned woodlands.

Table 3. — Commercial Forest Area by Ownership and Physiographic Region, 1948[a]

Ownership	State		Prairie	Claypan	Southern
	thousand acres	*percent*	*thousand acres*		
Federal:					
National forest	147	3.7	0	0	147
Other	32	.8	16	6	10
Total	**179**	**4.5**	**16**	**6**	**157**
State	10	.3	6	0	4
Private	3,752	95.2	1,542	1,341	869
Total	**3,941**	....	**1,564**	**1,347**	**1,030**
Percent of total	...	*100.0*	*39.7*	*34.2*	*26.1*

[a] Does not include 55,000 acres of forest land classified as noncommercial.

Five percent of the Illinois commercial forest land, 189,000 acres, is in public ownership. The commercial forest land in federal wildlife refuges and military reservations totals 32,000 acres. As of 1948, 147,000 acres of commercial forest land is included in the 197,000 acres of federally owned land in the Shawnee National Forest in the Southern region. The state owns about 10,000 acres of commercial forest land as well as an additional 18,000 acres of forest land that has been withdrawn from commercial timber production for use as state parks and wildlife refuges. All of the 26,000 acres of Illinois forest land owned by counties and municipalities has been withdrawn from commercial timber production, chiefly for recreational use and the protection of reservoir watersheds.

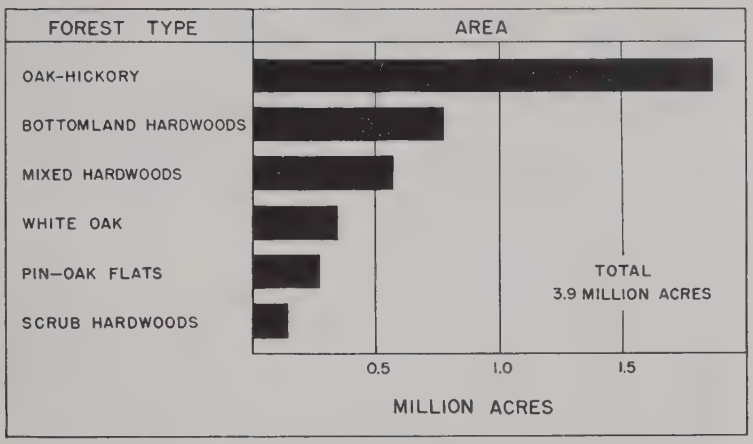
Forest types

Forest types are classified on the basis of the species composition of the stand. The differences in species composition among some of the Illinois forest types are not great, and the occurrence of the important species shifts with changes in locality, soil characteristics, exposure, and topography. Furthermore, the change from one forest type to another is often gradual. Oak species predominate on more than 60 percent of the forest land and occur in mixture with a large number of other species.

The oak-hickory type is the most extensive type in each of the Survey regions (Table 4). It occupies approximately 1.9 million acres, 47 percent of all commercial forest land in the state (Fig. 11). This type is generally found on well-drained sites (Fig. 12) and is composed primarily of oaks, hickory, and elm with some hard maple, ash, black walnut, and other hardwoods. In this type, black oak predominates in the Southern and Claypan regions, while in the Prairie region, northern red oak is the most common species. The proportion of hickory varies among regions and increases considerably from north to south.

Table 4. — Commercial Forest Area by Forest Type and Physiographic Region, 1948

Forest type	State		Prairie	Claypan	Southern
	thousand acres	*percent*	*thousand acres*		
Oak-hickory	1,854	47.1	621	673	560
Bottomland hardwoods	777	19.7	318	265	194
Mixed hardwoods	569	14.4	344	142	83
White oak	340	8.6	185	111	44
Pin-oak flats	267	6.8	4	133	130
Scrub hardwoods	134	3.4	92	23	19
Total	**3,941**	....	**1,564**	**1,347**	**1,030**
Percent of total	...	*100.0*	*39.7*	*34.2*	*26.1*



Commercial forest area in Illinois by forest type, 1948. (Fig. 11)

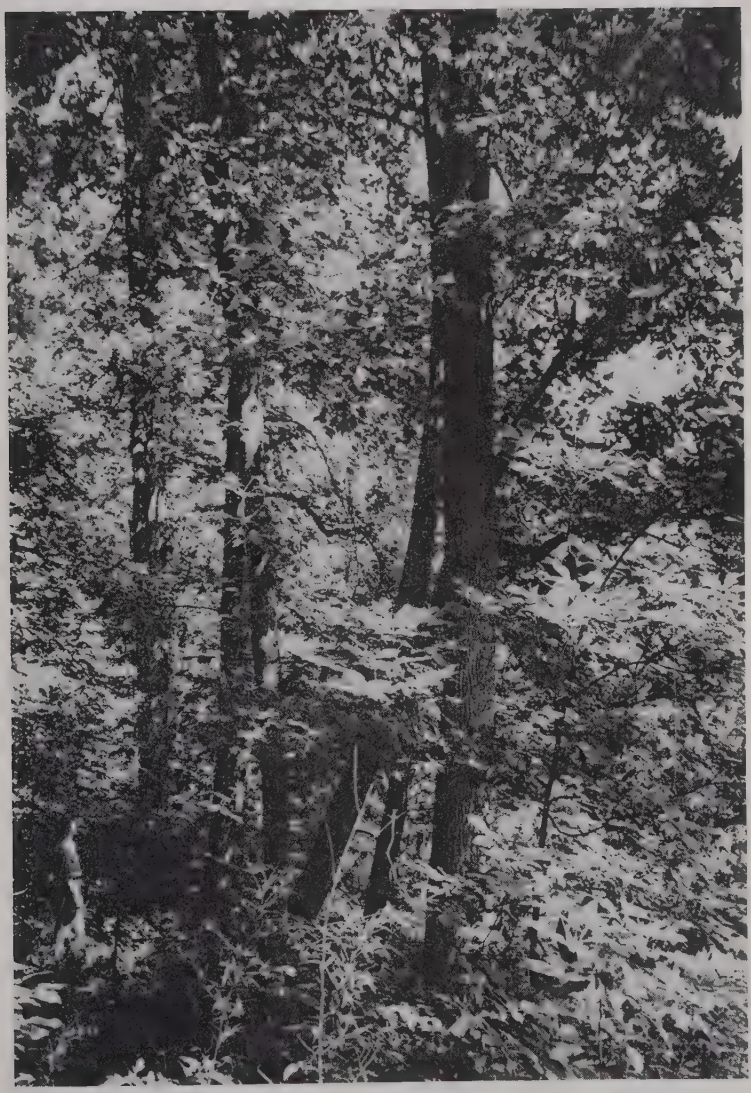
The oak-hickory type of forest occupies almost half the commercial forest land in Illinois and generally occurs on well-drained sites. (Fig. 12)

The bottomland hardwoods occupy approximately 777,000 acres, one-fifth of all commercial forest land. This type is found on the flood plains of the rivers and streams. The principal species include soft maple, elm, cottonwood, sycamore, hickory, ash, and, in southern Illinois, a relatively small volume of cypress. This type is about equally predominant in all regions and, because it generally occurs on sites of exceptionally high productivity, is one of the most important timber-producing types in the state (Fig. 13).

Bottomland hardwoods generally occupy sites of exceptionally high productivity on the flood plains of the rivers and streams. (Fig. 13)

The mixed hardwood type covers 569,000 acres, 14 percent of the commercial forest land in the state. It is more prevalent in the north than in the south. Northern red oak, elm, white oak, yellow-poplar, basswood, maple, hickory, and black walnut are common in this type. The species composition varies within the type from region to region. Yellow-poplar and black oak predominate in the Southern region (Fig. 14); soft maple and elm are most common in the Claypan region, and northern red oak predominates in the Prairie region. The proportion of white oak in the mixed hardwood type is fairly constant throughout all regions.

The white oak type is commoner in the Prairie region than in the others, and the proportion of forest land in this type diminishes gradually from north to south. Approximately 340,000 acres, 9 percent



The species composition of the mixed hardwood types of forest varies among the different regions of Illinois. Yellow-poplar and black oak predominate in this type of forest in the Southern region. (Fig. 14)

of all commercial forest land, is in this type. It is composed primarily of white oak with a mixture of other oaks, elm, hickory, hard maple, black walnut, and other hardwoods. The acreage of the white oak type does not indicate the importance of the white oak species in Illinois, because this species also occurs in other types. White oak makes up one-fifth of all saw timber in Illinois. The volume of this valuable species exceeds that of any other in the state.

The pin oak flats are largely confined to poorly drained areas in the Southern and Claypan regions (Fig. 15). This type covers 267,000 acres, 7 percent of all commercial forest land. The principal species include the red oaks (primarily pin oak), the post-oak group (chiefly post oak and swamp white oak), elm, hickory, and ash.

Scrub hardwoods occupy 134,000 acres, about 3 percent of all commercial forest land. The scrub hardwoods include noncommercial tree species such as hawthorn, wild plum, and sumac, as well as scrub trees of commercial species, primarily elm. Scrub hardwoods often are

Pin oak flats are found mostly in poorly drained areas in the Southern and Claypan regions of the state. (Fig. 15)

found on productive sites where the trees are stunted and deformed through mistreatment rather than lack of soil productivity. Especially in the Prairie region, where this type is most prevalent, the development of scrub hardwood cover is often the direct result of continuous overgrazing on forest land.

Stand-size classes

The Forest Survey recognizes five forest stand-size classes: large saw timber, small saw timber, pole timber, seedlings and saplings, and nonstocked.

Saw-timber stands. Timber stands with enough volume to be classed as saw-timber areas occur on 1.8 million acres, 46 percent of the commercial forest land (Table 5). The proportion of commercial forest land classified as saw-timber area is practically the same in each of the three regions.

However, the proportion does vary by forest type (Table 6). None of the scrub hardwood type qualifies as saw-timber area. The oak-hickory and mixed hardwood types each average about 40 to 45 percent saw-timber area, and the bottomland hardwoods, about 49 percent. The proportion of the pin oak flats in saw-timber stands is greater, 61 percent, probably because of less intensive cutting in this type, which is composed largely of less desirable species. Of all the forest types, the white oak type has the greatest proportion in saw-timber stands — 79 percent. This type, however, makes up less than 9 percent of the total commercial forest area. Many of the white oak stands, especially in the Prairie region, are in the woodlands of prosperous farmers who for many years have withheld them from cutting for sentimental reasons (Fig. 16).

In all forest types combined, more than two-thirds of the saw-timber area contains enough volume in trees 15 inches d.b.h. and larger to be classed as large saw-timber area (Fig. 17).

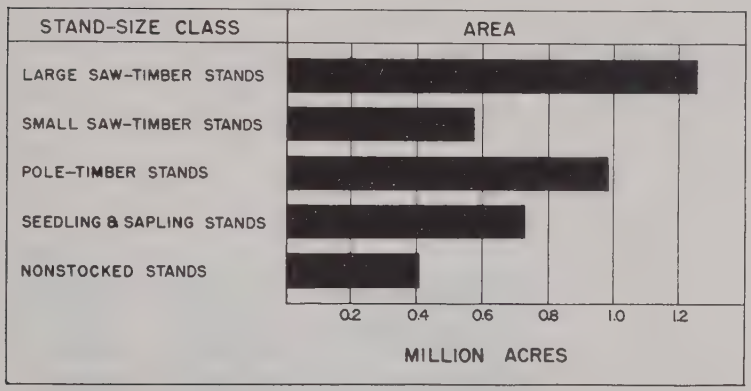
Table 5. — Commercial Forest Area by Stand-Size Class and Physiographic Region, 1948

Stand-size class	State		Prairie	Claypan	Southern
	thousand acres	*percent*	*thousand acres*		
Large saw-timber stands	1,251	31.8	496	440	315
Small saw-timber stands	573	14.5	224	180	169
Pole-timber stands	983	24.9	340	357	286
Seedling and sapling stands	729	18.5	276	250	203
Nonstocked stands	405	10.3	228	120	57
Total	**3,941**	....	**1,564**	**1,347**	**1,030**
Percent of total	...	*100.0*	*39.7*	*34.2*	*26.1*

Table 6. — Commercial Forest Area by Forest Type and Stand-Size Class, 1948

Forest type	Total		Large saw-timber stands	Small saw-timber stands	Pole-timber stands	Seedling and sapling stands	Non-stocked stands
	thousand acres	*percent*	*thousand acres*				
Oak-hickory	1,854	47.1	489	272	499	463	131
Bottomland hardwoods	777	19.7	303	81	180	86	127
Mixed hardwoods	569	14.4	181	67	189	120	12
White oak	340	8.6	177	92	39	13	19
Pin-oak flats	267	6.8	101	61	68	27	10
Scrub hardwoods	134	3.4	...	...	8	20	106
Total	**3,941**	....	**1,251**	**573**	**983**	**729**	**405**
Percent of total	....	*100.0*	*31.8*	*14.5*	*24.9*	*18.5*	*10.3*

Many of the white oak stands, especially in the Prairie region, are in the woodlands of prosperous farms and have been withheld from cutting for sentimental reasons. (Fig. 16)



Commercial forest area in Illinois by stand-size class, 1948. (Fig. 17)

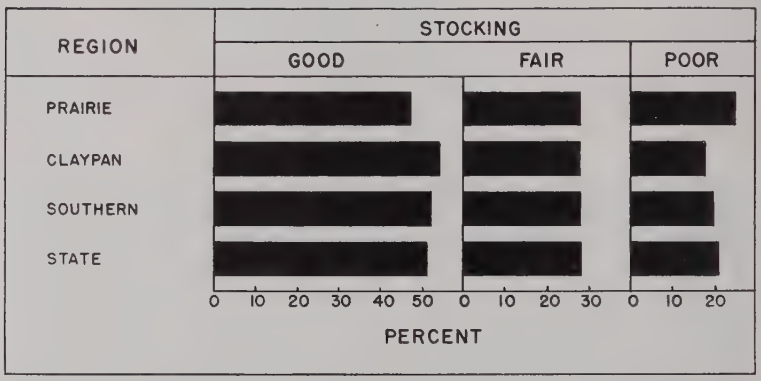
Other stands. Immature stands, other than saw timber, occupy 54 percent of the commercial forest land. Pole-timber areas contribute 25 percent; seedling and sapling areas, 19 percent; and nonstocked areas, 10 percent. With the exception of nonstocked areas, the distribution of forest area by stand-size class varies little from region to region. The nonstocked areas make up 15 percent of the commercial forest land in the Prairie region as compared to 9 percent and 6 percent, respectively, in the Claypan and Southern regions. These differences are believed to be largely due to variations in woodland grazing intensity, with the heaviest grazing, and therefore the greatest damage to forest reproduction, in the Prairie region.

Stocking

On the basis of crown coverage of all tree-size classes combined, excluding cull trees and trees of noncommercial species, 51 percent of the commercial forest land has good stocking; 28 percent has fair stocking; and 21 percent, poor (Fig. 18). On the same basis, 66 percent of the saw-timber area, 54 percent of the pole-timber area, and 33 percent of the seedling and sapling area have good stocking. Because young trees have smaller crowns than saw-timber trees, these estimates for the younger stands probably indicate a lower degree of stocking than would estimates based on some other criterion, such as number of stems per acre.

Good stocking does not always indicate a satisfactory stand. Especially in the large saw-timber areas, the stands often contain

a high proportion of old, decadent trees of low quality. Furthermore, the species composition of many well-stocked stands is unsatisfactory. One should also recognize that poor stocking does not necessarily indicate a poor site. Cutting, grazing, or burning may result in poor tree stocking on sites capable of supporting dense timber stands.



Commercial forest area in Illinois by physiographic region and stocking class, 1948. (Fig. 18)

The differences among regions in the intensity of woodland grazing are reflected in the forest stocking statistics. Despite less intensive timber harvesting, the average stocking of the woodlands is poorest in the Prairie region, where woodland grazing is most prevalent. Roughly 25 percent of the forest area in the Prairie region is poorly stocked as compared with 19 percent in the rest of the state. Almost three-fourths of the poorly stocked woodland area in the Prairie region, but only 34 percent in the Southern region, is heavily grazed. The forest cover on many of these heavily grazed woodlands consists of an understocked saw-timber stand with little or no understory of tree reproduction.

Unless such stands are protected from grazing damage to permit growth and development of tree reproduction, sustained yield is impossible, and the forest cover will eventually be eliminated. However, if protection is provided in time, most of these understocked areas will recover. The ability of hardwood stands to improve in density, quality, and rate of growth under good protection and management has been demonstrated in the national and state forests.

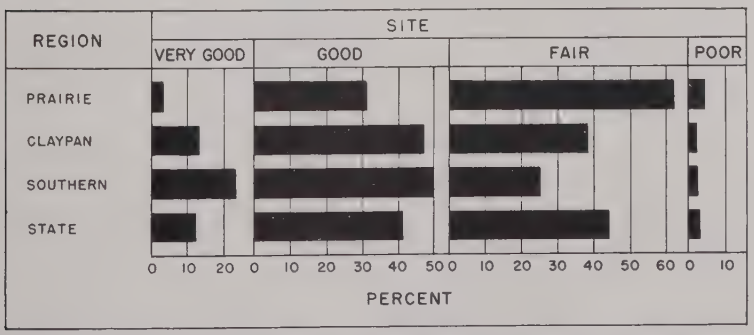
Site quality

The ability of an area to grow timber is chiefly determined by the chemical and physical properties of the soil (including water relations), and by topography, climate, elevation, and exposure. The combined effect of these factors on growth determines the quality of the site.

The Forest Survey recognized four hardwood site classes in Illinois: very good, good, fair, and poor. The site classification is based on the average merchantable height that can be obtained on the area by mature hardwood trees (except tulip-poplar and cottonwood) under present growing conditions. Merchantable height is estimated to the nearest one-half of a 16-foot log. Tulip-poplar and cottonwood trees, as well as softwood trees, generally average one log taller at maturity than other hardwoods on identical sites.

It may be that the site evaluations are conservative. Frequently the only trees available for site determination are trees left after one or more logging operations. As a result, they are often shorter and limbier than the trees that once grew on the area. An effort was made to compensate for this by increasing the merchantable height on a judgment basis, but possibly the adjustment was not great enough.

Forest lands that can produce hardwood trees which at maturity average three logs or more are classified as very good sites; they make up 12 percent of the commercial forest land in Illinois (Fig. 19). A number of relatively small areas, particularly in the rich moist bottomlands, can produce 4- and 5-log hardwoods, but the acreage of these areas amounts to only 1 percent of the commercial forest land.



Commercial forest area in Illinois by physiographic region and site-quality class, 1948. **(Fig. 19)**

Approximately 41 percent of the total area is classified as good site (2 to 2½ logs), and 44 percent as fair (1 to 1½ logs). Three percent of the commercial forest land is classified as poor site, only capable of producing hardwoods which average ½ log.

The proportion of forest land in each site class varies by region. Considering all types of land combined, the Prairie region has the best sites of the three regions. However, considering only the forest land, the Prairie region averages the poorest in site productivity. Fair and poor sites total 66 percent of the commercial forest area in this region, as compared to 40 and 27 percent, respectively, in the Claypan and Southern regions. The proportion of forest land classified as good site is 31 percent in the Prairie region, but it is 47 and 50 percent in the other regions. Very good sites, which make up 23 percent of the total area in the Southern and 13 percent in the Claypan region, make up only 3 percent of the Prairie woodland area.

Several factors contribute to the poor average site productivity of forest land in the Prairie region. Although a number of farm woodlands in this region are located on very good sites, the bulk of the forest area consists of small scattered tracts generally located on the least productive lands, such as rough breaks with thin soils, and poorly drained areas; the more productive lands are used for cultivated crops or pasture. Heavy grazing in the woodlands, as generally practiced here, is detrimental to the tree growth. Regional differences in the length of growing season and in the distribution and volume of precipitation possibly have some effect. The length of growing season in the extreme south exceeds that in the north by more than 40 percent, and the annual volume of precipitation in the south is more than 50 percent greater than that in the north.

The site quality of many forest areas throughout the state can probably be improved through better protection from fire and grazing damage and through widespread application of better forest management practices.

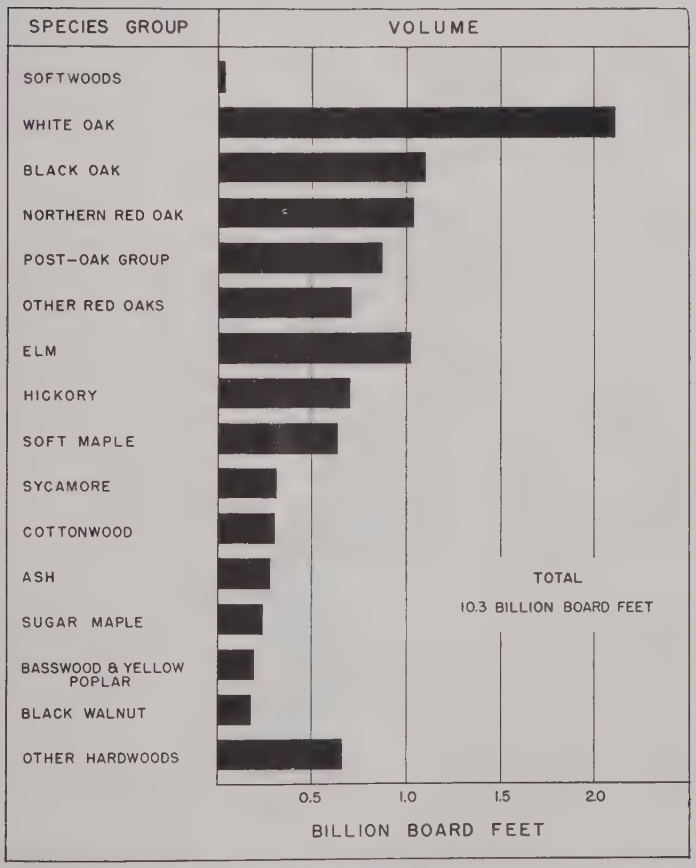
Timber Volume

Board-foot volume

Net volume. As of the beginning of 1948, the net board-foot volume of saw timber in Illinois totaled 10.3 billion board feet. The oak species total 56 percent of the net board-foot volume, white oak alone accounting for 21 percent of the total, and black oak and northern red oak each making up about 10 percent (Table 7 and Fig. 20). Other species most prevalent are elm, hickory, soft maple, sycamore,

and cottonwood. In general, the proportion of white oak, northern red oak, elm, and sugar maple increases from south to north. On the other hand, hickory, pin oak, and sycamore are more common in the south than in the north. The stands on the Claypan region contain the largest proportions of black oak, soft maple, and ash. Of the softwoods, redcedar and cypress are most common in Illinois, but softwoods are of minor importance.

Stands classified as large saw timber, which occupy 32 percent of



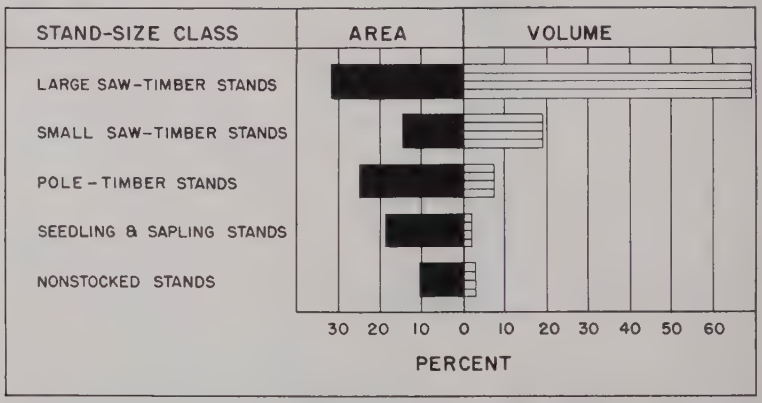
Net board-foot volume on the commercial forest area, by species group, 1948. The oak species are by far the most prevalent. (Fig. 20)

Table 7. — Net Board-Foot Volume on Commercial Forest Area by Species and Physiographic Region, 1948

Species	State		Prairie	Claypan	Southern
	million bd. ft.	*percent*	*million board feet*		
Softwoods[a]	39	.4	19	...	20
White oak	2,104	20.5	1,017	690	397
Black oak	1,085	10.6	384	418	283
Northern red oak	1,028	10.0	649	151	228
Post-oak group	864	8.4	370	323	171
Other red oaks	702	6.9	14	334	354
Elm	1,016	9.9	548	332	136
Hickory	692	6.8	143	305	244
Soft maple	630	6.1	219	303	108
Sycamore	310	3.0	101	108	101
Cottonwood	295	2.9	133	46	116
Ash	270	2.6	85	125	60
Sugar maple	230	2.3	167	31	32
Basswood and yellow-poplar	178	1.7	105	5	68
Black walnut	167	1.6	67	78	22
Other hardwoods	648	6.3	152	233	263
Total	**10,258**	...	**4,173**	**3,482**	**2,603**
Percent of total	....	*100.0*	*40.7*	*33.9*	*25.4*

[a] Chiefly redcedar and cypress.

the commercial forest area, contain 69 percent of the net board-foot volume (Fig. 21 and Table 8). About 19 percent of the total volume is in small saw-timber stands. The remaining 12 percent is made up of saw-timber trees scattered throughout the younger stand-size classes, which occupy 54 percent of the commercial forest area. Largely the remnants of the original stands, these scattered trees were locally unmerchantable at the time of the last cut, but are now merchantable because of added growth or because of the lowering of local merchant-



Commercial forest area in Illinois and net board-foot volume, by stand-size class, 1948. About 88 percent of the volume is in saw-timber stands. (Fig. 21)

Table 8. — Net Board-Foot Volume on Commercial Forest Area by Species and Stand-Size Class, 1948

Species	Total		Large saw-timber stands	Small saw-timber stands	Pole-timber stands	Seedling and sapling stands	Non-stocked stands
	million bd. ft.	*percent*	*million board feet*				
Softwoods[a]	39	.4	16	22	..	1	..
White oak	2,104	20.5	1,383	509	114	50	48
Black oak	1,085	10.6	753	224	81	14	13
Northern red oak	1,028	10.0	824	132	57	15	..
Post-oak group	864	8.4	566	149	100	11	38
Other red oaks	702	6.9	420	182	59	25	16
Elm	1,016	9.9	675	154	100	35	52
Hickory	692	6.8	437	155	75	8	17
Soft maple	630	6.1	512	65	20	5	28
Sycamore	310	3.0	230	25	11	3	41
Cottonwood	295	2.9	194	83	14	2	2
Ash	270	2.6	199	60	10	1	..
Sugar maple	230	2.3	161	34	6	26	3
Basswood and yellow-poplar	178	1.7	146	14	12	..	6
Black walnut	167	1.6	129	24	5	4	5
Other hardwoods	648	6.3	457	111	68	2	10
Total	**10,258**	....	**7,102**	**1,943**	**732**	**202**	**279**
Percent of total	....	*100.0*	*69.2*	*19.0*	*7.1*	*2.0*	*2.7*

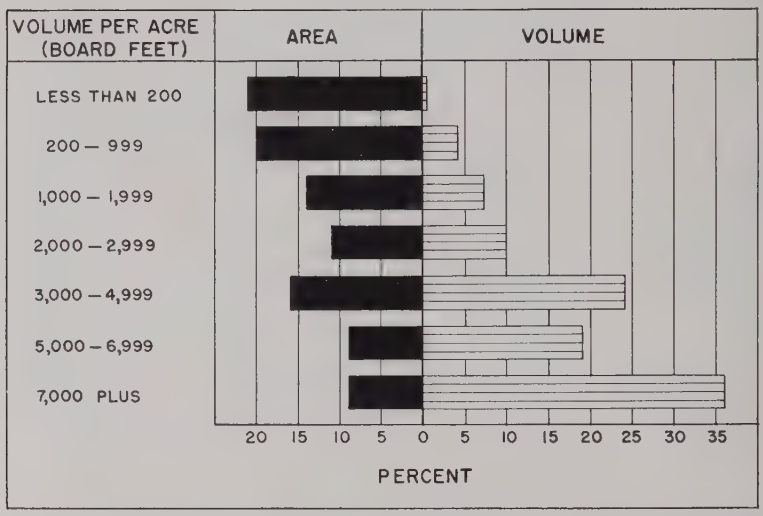
[a] Chiefly redcedar and cypress.

ability standards. The distribution of saw-timber volume by stand-size class varies little among the regions. Although virgin timber can be found in a number of small scattered tracts, practically all of the saw timber in Illinois is in second-growth stands.

Except for some of the small, scattered stands in the Prairie region, the distribution of the saw-timber volume over the forest area is generally favorable for timber harvesting operations. The net volume of saw timber on the commercial forest area averages 2,603 board feet per acre. Roughly 36 percent of the volume is in stands which contain 7,000 or more board feet per acre (Fig. 22); such stands occupy 9 percent of the commercial forest area. Stands which support from 3,000 to 6,999 board feet per acre contain 43 percent of the total saw-timber volume and occupy 25 percent of the total area. Approximately 17 percent of the net board-foot volume occurs on that 25 percent of the commercial forest area which supports 1,000 to 2,999 board feet per acre. Only 4 percent of the total volume is in stands of less than 1,000 board feet per acre, which total 41 percent of the commercial forest area.

Present operations in Illinois, which generally involve small portable mills and truck hauling over a well-distributed network of roads, can be profitable even in relatively sparse stands.

The distribution of saw-timber volume by tree-diameter class is practically the same in each of the three regions (Table 9). Approximately 30 percent of the net board-foot volume is in trees of the 12-



Commercial forest area in Illinois and net board-foot volume, by volume-per-acre class, 1948. (Fig. 22)

Table 9. — Net Board-Foot Volume on Commercial Forest Area by Tree-Diameter Class and Physiographic Region, 1948

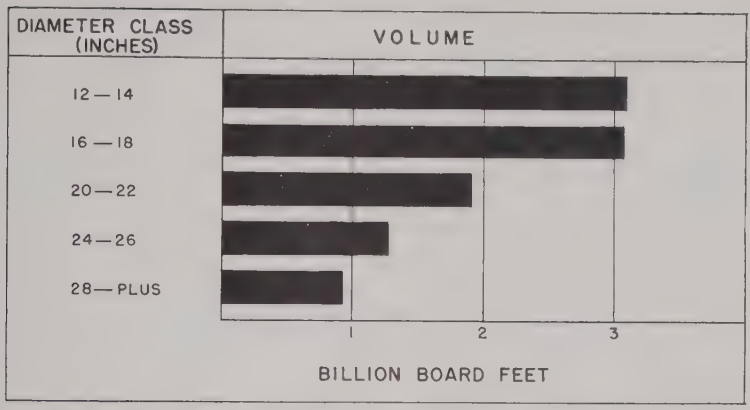
Tree-diameter (inches)	State		Prairie		Claypan		Southern	
	Million bd. ft.	Percent of state volume	Million bd. ft.	Percent of volume in region	Million bd. ft.	Percent of volume in region	Million bd. ft.	Percent of volume in region
9.0 to 10.9[a]	5	.1	4	.1	....	....	1	[b]
11.0 to 14.9	3,086	30.1	1,205	28.9	1,007	28.9	874	33.6
15.0 to 18.9	3,082	30.0	1,226	29.4	1,107	31.8	749	28.8
19.0 to 22.9	1,906	18.6	837	20.1	616	17.7	453	17.4
23.0 to 26.9	1,251	12.2	544	13.0	434	12.5	273	10.5
27.0 and larger	928	9.0	357	8.5	318	9.1	253	9.7
Total	**10,258**	**100.0**	**4,173**	**100.0**	**3,482**	**100.0**	**2,603**	**100.0**
Percent of state volume	*100.0*	....	*40.7*	....	*33.9*	....	*25.4*	....

[a] Includes only softwoods.
[b] Less than 0.05 percent.

and 14-inch tree diameter classes (Fig. 23),[1] and another 30 percent of the total volume is in trees of the 16- and 18-inch classes. The remaining 40 percent is in trees of the 20-inch class and larger, almost one-fourth of this percentage being in trees with diameters of at least 27 inches.

The distribution of saw-timber volume by tree-diameter class varies by species. In general, the fast-growing bottomland species

[1] For explanation of diameter classes, see page 94.



Net board-foot volume on the Illinois commercial forest area, by tree-diameter class, 1948. (The bar representing the 12-14-inch class includes 5 million board feet in 10-inch softwood trees.) (Fig. 23)

Table 10. — Net Board-Foot Volume on Commercial Forest Area by Species and Tree-Diameter Class, 1948

Species	Total	Tree-diameter class (inches)				
		12-14	16-18	20-22	24-26	28 and larger
		million board feet				
Softwoods[a]	39	20[b]	5	...	6	8
White oak	2,104	770	737	323	155	119
Black oak	1,085	241	354	246	159	85
Northern red oak	1,028	206	299	189	166	168
Post-oak group	864	228	278	216	73	69
Other red oaks	702	205	172	112	160	53
Elm	1,016	334	318	182	91	91
Hickory	692	321	227	102	24	18
Soft maple	630	157	153	128	104	88
Sycamore	310	33	60	65	80	72
Cottonwood	295	63	69	70	42	51
Ash	270	108	88	46	28	..
Sugar maple	230	79	83	48	4	16
Basswood and yellow-poplar	178	37	44	44	19	34
Black walnut	167	91	47	15	6	8
Other hardwoods	648	198	148	120	134	48
Total	**10,258**	**3,091**	**3,082**	**1,906**	**1,251**	**928**
Percent of total	*100.0*	*30.2*	*30.0*	*18.6*	*12.2*	*9.0*

[a] Chiefly redcedar and cypress.
[b] Includes 5 million board feet of 10-inch softwoods.

such as soft maple, sycamore, and cottonwood have the greatest proportion of total volume in trees of large diameter (Table 10). Some species for which the commercial demand is low, such as beech and pin oak, have a high proportion of total volume in large trees, chiefly because they have not been subjected to heavy cutting. In trees of the

Table 11. — Net Board-Foot Volume on Commercial Forest Area by Forest Type and Physiographic Region, 1948

Forest type	State		Prairie	Claypan	Southern
	million bd. ft.	*percent*	*million board feet*		
Oak-hickory	4,099	39.9	1,785	1,326	988
Bottomland hardwoods	2,541	24.8	767	934	840
Mixed hardwoods	1,427	13.9	835	306	286
White oak	1,383	13.5	754	482	147
Pin-oak flats	779	7.6	18	419	342
Scrub hardwoods	29	.3	14	15	...
Total	**10,258**	....	**4,173**	**3,482**	**2,603**
Percent of total	.....	*100.0*	*40.7*	*33.9*	*25.4*

Table 12. — Net Board-Foot Volume on Commercial Forest Area by Ownership and Physiographic Region, 1948

Ownership	State		Prairie	Claypan	Southern
Federal:	*million bd. ft.*	*percent*	*million board feet*		
National forest	328	3.2	0	0	328
Other	84	.8	43	15	26
Total	**412**	**4.0**	**43**	**15**	**354**
State	26	.3	16	0	10
Private	9,820	95.7	4,114	3,467	2,239
Total	**10,258**	....	**4,173**	**3,482**	**2,603**
Percent of total	.....	*100.0*	*40.7*	*33.9*	*25.4*

more valuable species, such as white oak, black walnut, ash, and sugar maple, past cutting has been concentrated on the larger trees, thus reducing the proportion of total volume in trees of large diameter.

Characteristics of the growing stock. The preceding statistics probably create too favorable a picture of the present stocking and distribution of timber in Illinois. Although the volume of timber on the forest area appears to be rather good, and does provide a sound base for forest management and the development of a valuable future forest, the Illinois forest land has a far greater potential yield, both in volume and quality of timber. Under improved protection and management, the timber stand on the present forest area could probably be built up to three times the present volume, with a much greater proportion of the total volume in high-quality trees.

The over-all quality of the timber stand has been reduced by woodland grazing, improper cutting practices, and fire. The present stand contains many overmature and decadent trees which should be removed and replaced by thrifty, fast-growing trees. Many of the sawtimber trees scattered over the seedling and sapling and nonstocked areas are remnants of the original stand and contain a high proportion of cull. Continued overgrazing, especially in the Prairie region,

Table 13. — Hardwood Saw-Timber Volume by Species Group and Percentage Distribution in Log Grades, 1948

Species group	Volume	Log grade 1	Log grade 2	Log grade 3
	million bd. ft.		*percent*	
White oaks[a]	2,968	4.7	14.4	80.9
Red oaks[b]	2,815	8.6	16.8	74.6
Other hardwoods	4,436	8.8	16.6	74.6
All hardwoods	**10,219**	**7.6**	**16.0**	**76.4**

[a] Includes white oak and post-oak group.
[b] Includes black oak, northern red oak, and other red oaks.

Table 14. — Hardwood Saw-Timber Volume by Physiographic Region and Percentage Distribution in Log Grades, 1948

Physiographic region	Volume	Log grade 1	Log grade 2	Log grade 3
	million bd. ft.		*percent*	
Prairie	4,154	7.0	15.7	77.3
Claypan	3,482	6.5	20.6	72.9
Southern	2,583	10.1	10.2	79.7
State	**10,219**	**7.6**	**16.0**	**76.4**

has destroyed the tree reproduction in many of the timber stands. Unless such woodlands are protected from livestock to permit the development of tree reproduction, the forest cannot perpetuate itself and will eventually disappear.

More than three-fourths of the total saw-timber volume is in logs of grade 3 which, when sawed, normally produce less than 25 percent No. 1 common and better lumber, or are suitable only for ties or timbers (Tables 13 and 14). The remaining one-fourth is in logs of grades 1 and 2 (approximately 8 percent in grade 1), which yield most of the high-quality materials required by the tight cooperage, veneer, and furniture industries.

In interpreting these log-grade statistics, one must remember that log grade is based on size of log as well as quality. As a general rule, only trees more than 17 inches d.b.h. can produce logs large enough to qualify as grade 1, and trees must exceed 15 inches d.b.h. to produce logs of grade 2. Many of the smaller trees are of good form and quality, but because of their size do not contain top-quality logs. The volume in high-grade logs will increase as the proportion of total volume in relatively large trees is built up through improved forest management.

Cull volume. The present timber stands in Illinois contain many cull and defective trees not included in the foregoing volume estimates. The cull volume, including both cull trees and cull material in mer-

Table 15. — Number of Sound Trees on Commercial Forest Area by Species and Tree-Diameter Class, 1948[a]

Species	Total	Tree-diameter class (inches)										
		2	4	6	8	10	12	14	16	18	20	22+
		million trees										
Softwoods	2.3	.3	.6	.6	.2	.2	.2	.1	.1	..	..	..
White oak	81.3	32.8	10.0	9.7	7.2	5.7	4.6	5.0	2.4	1.9	.9	1.1
Black oak	79.9	46.2	16.3	4.5	3.2	3.1	1.5	1.6	1.2	.9	.5	.9
Northern red oak	18.8	6.5	2.1	2.1	1.6	1.1	1.1	1.3	1.0	.7	.2	1.1
Post-oak group	69.1	30.8	16.0	7.6	5.4	2.7	2.0	1.3	1.3	.6	.5	.9
Other red oaks	38.9	15.4	6.8	6.2	4.0	2.2	1.6	.9	.6	.3	.2	.7
Elm	173.4	96.2	35.6	15.9	10.2	5.0	3.0	2.9	1.8	1.2	.6	1.0
Hickory	160.0	91.5	35.6	14.7	7.5	4.1	3.0	1.7	1.0	.6	.2	.1
Soft maple	40.2	15.7	10.4	4.0	3.7	1.9	1.5	1.0	.6	.5	.3	.6
Sycamore	10.6	5.9	1.7	.8	.5	.3	.2	.2	.3	.2	.1	.4
Cottonwood	10.7	7.8	.3	.8	.3	.1	.3	.5	.2	.2	.1	.1
Ash	65.8	40.0	10.3	6.6	4.4	2.1	1.0	.6	.3	.4	.1	..
Sugar maple	38.3	26.1	5.9	2.0	1.0	1.3	.6	.5	.4	.3	.2	..
Basswood and yellow-poplar	9.0	4.1	2.1	.7	.7	.4	.3	.2	.2	.1	..	.2
Black walnut	25.8	11.9	4.9	4.2	1.5	1.5	.7	.8	.1	.2	..	..
Other hardwoods	193.6	126.8	37.6	13.8	6.5	4.1	1.7	1.1	.9	.2	.4	.5
Total	**1,017.7**	**558.0**	**196.2**	**94.2**	**57.9**	**35.8**	**23.3**	**19.7**	**12.4**	**8.3**	**4.3**	**7.6**

[a] Includes only merchantable or potentially merchantable trees.

chantable trees, makes up 24 percent of the gross board-foot volume in all saw-timber-sized trees on the commercial forest area. Roughly 19 percent of the gross board-foot volume is in cull trees, practically none of which are merchantable under present marketing standards. Considering only the saw-timber trees, those with sufficient sound volume to be merchantable, approximately 7 percent of the gross board-foot volume is cull material. The cull percentage is about the same in each of the three regions.

In addition to cull, a large part of the present volume consists of undesirable, slow-growing, and low-quality trees. One of the major problems in the Illinois forest program is the removal of cull and other undesirable trees to make room for trees of better quality.

Cubic-foot volume

Growing stock. The net cubic volume of growing stock, saw-timber and pole-timber sizes combined, totals 2.4 billion cubic feet (Table 16). About one-third of this volume is in pole-timber trees and two-thirds in the sawlog portion of saw-timber trees (Fig. 24). The proportion in pole-timber trees varies from 31 percent in the Prairie region to 39 percent in the Southern region, with 33 percent in the Claypan region. The proportion in pole timber is least in the Prairie region primarily because tree reproduction in this region has been subjected to the greatest grazing intensity and damage. It is also due in part to less intensive cutting of the saw-timber trees than in the other regions. The average saw-timber volume per acre is highest in the Prairie

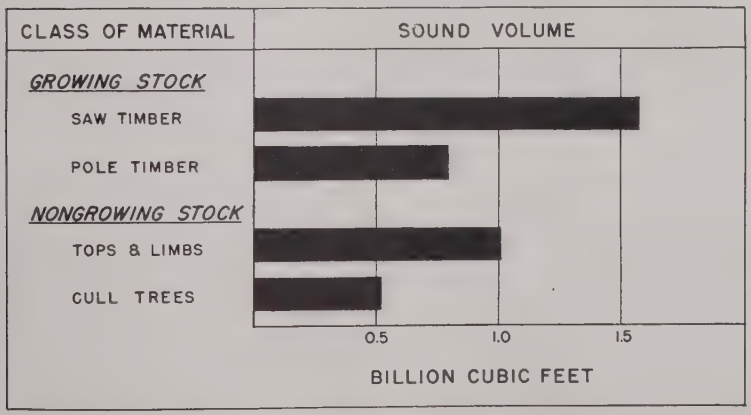
Table 16. — Net Cubic-Foot Volume on Commercial Forest Area by Species and Physiographic Region, 1948

Species	State		Prairie	Claypan	Southern
	million cu. ft.	*percent*	*million cubic feet*		
Softwoods[a]	11.6	0.5	7.1	.1	4.4
White oak	424.2	17.9	193.2	140.7	90.3
Black oak	216.8	9.2	77.3	81.3	58.2
Northern red oak	176.4	7.4	112.8	23.8	39.8
Post-oak group	184.1	7.8	63.1	75.8	45.2
Other red oaks	165.4	7.0	4.6	72.6	88.2
Elm	285.0	12.0	147.4	88.7	48.9
Hickory	211.8	8.9	49.5	78.0	84.3
Soft maple	147.1	6.2	56.3	66.0	24.8
Sycamore	55.4	2.3	17.2	20.5	17.7
Cottonwood	49.3	2.1	20.4	7.7	21.2
Ash	95.8	4.0	26.4	44.6	24.8
Sugar maple	55.0	2.3	36.3	8.2	10.5
Basswood and yellow-poplar	34.4	1.5	19.2	2.8	12.4
Black walnut	59.8	2.5	25.8	25.1	8.9
Other hardwoods	199.6	8.4	57.6	61.9	80.1
Total	**2,371.7**	...	**914.2**	**797.8**	**659.7**
Percent of total in state	.....	*100.0*	*38.6*	*33.6*	*27.8*

[a] Chiefly redcedar and cypress.

region — 2,668 board feet per acre as compared to 2,585 and 2,527 board feet in the Claypan and Southern regions (Table 17). However, because of less volume in pole-sized trees, the average cubic volume of saw timber and pole timber combined is lowest in the Prairie region.

The large saw-timber areas of the state contain 55 percent of the total cubic volume of growing stock (Table 18); the small saw-timber



Cubic volume of sound wood on the Illinois commercial forest area, by class of material, 1948. (Softwood saw-timber tops are included in the saw-timber growing stock.) (Fig. 24)

Table 17. — Average Volume of Growing Stock per Acre by Stand-Size Class and Region, 1948

Stand-size class	State	Prairie	Claypan	Southern
Board-foot volume				
Large saw-timber stands	5,677	5,784	5,548	5,689
Small saw-timber stands	3,391	3,598	3,244	3,272
Pole-timber stands	745	721	846	647
Seedling and sapling stands	277	301	248	281
Nonstocked stands	689	746	775	281
Total	**2,603**	**2,668**	**2,585**	**2,527**
Cubic-foot volume				
Large saw-timber stands	1,043.0	1,004.4	1,051.1	1,092.4
Small saw-timber stands	888.1	871.0	898.3	900.0
Pole-timber stands	457.8	484.4	401.7	496.2
Seedling and sapling stands	74.1	83.0	55.6	84.7
Nonstocked stands	133.3	146.1	135.8	77.2
Total	**601.8**	**584.5**	**592.3**	**640.5**

Table 18. — Net Cubic-Foot Volume on Commercial Forest Area by Stand-Size Class and Physiographic Region, 1948

Stand-size class	State		Prairie	Claypan	Southern
	million cu. ft.	*percent*	*million cubic feet*		
Large saw-timber stands	1,304.8	55.0	498.2	462.5	344.1
Small saw-timber stands	508.9	21.4	195.1	161.7	152.1
Pole-timber stands	450.0	19.0	164.7	143.4	141.9
Seedling and sapling stands	54.0	2.3	22.9	13.9	17.2
Nonstocked stands	54.0	2.3	33.3	16.3	4.4
Total	**2,371.7**	....	**914.2**	**797.8**	**659.7**
Percent of total in state	.....	*100.0*	*38.6*	*33.6*	*27.8*

Table 19. — Net Cubic-Foot Volume on Commercial Forest Area by Species and Tree-Diameter Class, 1948

Species	Total	Tree-diameter class (inches)						
		6-8	10	12-14	16-18	20-22	24-26	28+
		million cubic feet						
Softwoods[a]	11.6	1.5	1.5	4.4	1.4	....	1.3	1.5
White oak	424.2	52.3	53.7	122.4	110.6	46.6	22.1	16.5
Black oak	216.8	23.4	29.0	39.0	54.0	36.2	23.0	12.2
Northern red oak	176.4	13.8	11.1	32.6	45.0	27.1	23.5	23.3
Post-oak group	184.1	33.2	19.8	36.9	42.4	31.6	10.5	9.7
Other red oaks	165.4	36.6	21.6	33.4	26.4	16.4	23.3	7.7
Elm	285.0	78.2	47.4	55.3	49.7	27.7	13.5	13.2
Hickory	211.8	63.2	38.3	53.5	35.5	15.2	3.4	2.7
Soft maple	147.1	29.7	18.6	26.0	23.9	19.7	16.0	13.2
Sycamore	55.4	4.7	3.7	5.8	9.3	9.9	11.7	10.3
Cottonwood	49.3	3.0	1.3	10.5	10.8	10.5	6.1	7.1
Ash	95.8	33.2	20.0	17.8	13.8	7.0	4.0	....
Sugar maple	55.0	8.5	11.3	12.8	12.6	6.9	.6	2.3
Basswood and yellow-poplar	34.4	4.5	3.3	5.7	7.0	6.4	2.7	4.8
Black walnut	59.8	18.5	14.8	14.8	7.3	2.3	.9	1.2
Other hardwoods	199.6	60.7	39.2	33.1	22.9	17.5	19.6	6.6
Total	**2,371.7**	**465.0**	**334.6**	**504.0**	**472.6**	**281.0**	**182.2**	**132.3**
Percent of total in state	*100.0*	*19.6*	*14.1*	*21.3*	*19.9*	*11.8*	*7.7*	*5.6*

[a] Chiefly redcedar and cypress.

areas, nearly 22 percent; pole-timber areas, 19 percent; and the seedling and sapling and the nonstocked areas, a little over 2 percent each. In each region, the percentages are close to those for the state as a whole.

The volume of total growing stock is distributed among the species in about the same proportions as is the saw-timber volume. In general, the proportion of total growing-stock volume in the various oak species is slightly less than the proportion of saw-timber volume, and that of hickory, elm, and ash is slightly greater. The combined volumes of the oak species make up roughly half of the total with white oak the most important single species (Table 19). Elm, hickory, and soft maple are again the most prevalent of the other species. The species composition of the total growing stock, as well as the density and distribution of stocking, is favorable for the management and development of the Illinois forest resource.

Sound wood other than growing stock. In addition to the 2.4 billion cubic feet of growing stock, the Illinois forest contains 1.5 billion cubic feet of sound wood in the tops and limbs of hardwood saw-timber trees and in cull trees, including trees of noncommercial species (Fig. 24 and Table 20). This 1.5 billion cubic feet is 40 times

Table 20. — Cubic Volume of Sound Wood on Commercial Forest Area by Species and Class of Material, 1948

Species	All material	Growing stock			Hardwood tops and limbs[b]	Cull trees[c]
		Total[a]	Saw-timber trees[a]	Pole-timber trees		
	million cubic feet					
Softwoods[d]	11.7	11.6	10.1	1.5	....	.1
White oak	669.6	424.2	318.2	106.0	203.7	41.7
Black oak	350.1	216.8	164.4	52.4	105.2	28.1
Northern red oak	292.4	176.4	151.5	24.9	96.9	19.1
Post-oak group	306.8	184.1	131.1	53.0	83.8	38.9
Other red oaks	264.1	165.4	107.2	58.2	68.6	30.1
Elm	467.2	285.0	159.4	125.6	102.1	80.1
Hickory	297.0	211.8	110.3	101.5	70.5	14.7
Soft maple	296.3	147.1	98.8	48.3	63.2	86.0
Sycamore	92.5	55.4	47.0	8.4	30.1	7.0
Cottonwood	81.9	49.3	45.0	4.3	28.9	3.7
Ash	148.5	95.8	42.6	53.2	27.3	25.4
Sugar maple	85.2	55.0	35.2	19.8	22.6	7.6
Basswood and yellow-poplar	72.4	34.4	26.6	7.8	17.0	21.0
Black walnut	90.3	59.8	26.5	33.3	17.0	13.5
Other hardwoods	346.6	199.6	99.7	99.9	63.7	83.3
Noncommercial species	14.3	.....	.....	....	....	14.3
Total	**3,886.9[e]**	**2,371.7**	**1,573.6**	**798.1**	**1,000.6**	**514.6[e]**
Percent of total in state	*100.0*	*61.0*	*40.5*	*20.5*	*25.8*	*13.2*

[a] Includes tops of softwood saw timber.
[b] Includes tops and limbs of saw-timber growing-stock trees only.
[c] Includes tops and limbs of cull saw-timber trees.
[d] Chiefly redcedar and cypress.
[e] Includes trees of noncommercial species.

Table 21. — Cord Volume[a] of Sound Wood on Commercial Forest Area by Class of Material and Physiographic Region, 1948

Class of material	State	Prairie	Claypan	Southern
		thousand cords		
Growing stock:				
Saw-timber trees[b]	24,016	9,706	8,186	6,124
Pole-timber trees	12,283	4,294	4,035	3,954
Total[b]	**36,299**	**14,000**	**12,221**	**10,078**
Hardwood tops and limbs	15,288	6,163	5,239	3,886
Cull trees[c]	7,840	3,545	2,261	2,034
Total	**59,427**	**23,708**	**19,721**	**15,998**
Percent of state total	*100.0*	*39.9*	*33.2*	*26.9*

[a] Standard cords, including bark.
[b] Includes tops of softwood saw timber.
[c] Includes trees of noncommercial species.

the total volume taken during 1947 from the Illinois forest growing stock for all wood products.

Very little of this material can be sold under present marketing conditions. Although a small volume is used for products of low value such as fuelwood, the labor costs involved in harvesting crooked and partially rotten trees discourage their use. If some method of utilizing low-grade wood could be found, the supply of wood could be extended and the better-quality materials saved for higher use. In addition, removal of cull trees would improve the forest silviculturally.

Timber Growth

Growth calculations are based upon changes in the diameter, height, and form of individual trees. The growth rate of individual trees in Illinois is generally good. However, because of understocking,

Table 22. — Average 10-Year Diameter Growth by Species and Tree Size Class

Species	Saw timber	Pole timber	Saplings
		inches	
White oak	1.82	1.44	1.20
Black oak	1.88	1.80	1.60
Northern red oak	2.02	1.32	1.72
Post-oak group	2.06	1.30	1.56
Other red oaks	3.16	2.68	1.80
Elm	2.52	2.00	1.68
Hickory	1.52	1.24	1.22
Soft maple	3.48	3.28	2.72
Sycamore	3.38	....	3.24
Cottonwood	4.96	....	....
Ash	1.84	1.68	1.96
Sugar maple	1.78	1.70	1.54
Basswood and yellow-poplar	2.32	1.60	2.10
Black walnut	2.56	2.88	1.76
Other species	2.56	2.62	1.66
All species	**2.26**	**1.90**	**1.64**

the average volume of growth per acre for the state as a whole is only one-third to one-half of what it could be. In general, the species commonly found on the rich, moist bottomlands have the fastest rates of growth; cottonwood has the highest average diameter growth of all major species, followed by soft maple and sycamore (Table 22). The red oaks, black walnut, and elm are also relatively fast-growing species. White oak, one of the most prevalent and most valuable species in the state, grows somewhat more slowly. From a commercial standpoint, there is no natural pine in Illinois, but the pine in plantations grows rapidly.

Net volume of growth. The net board-foot growth during 1947 amounted to 397 million board feet (Table 23), 4 percent of the volume of saw-timber growing stock at the beginning of the year. The 1947 net growth on the total growing stock, saw timber and pole timber combined, was 90.7 million cubic feet, 3.9 percent of the inventory volume.

Saw-timber ingrowth, the volume added annually to the saw-timber growing stock by pole-timber trees that grow into saw-timber size during the year, is an important part of the net growth of cut-over stands such as most of those in Illinois. It makes up 38 percent of the volume of annual net growth.

The proportion of net growth represented by ingrowth varies by species (Table 24). This is largely because the tree-size distribution differs among species, and this in turn is due to variations in cutting intensity and cutting practices. For example, several post species such as black locust, red mulberry, and catalpa are heavily cut before they reach maximum size. Such species, therefore, have a smaller-than-average proportion of their total volume in trees of saw-timber size, and ingrowth makes up a high proportion of the saw-timber net growth.

Table 23. — Change in Volume of Growing Stock During 1947

Item	Saw-timber growing stock	Total growing stock
	million bd. ft.	*million cu. ft.*
Growing stock, Jan. 1, 1947	10,024	2,319.4
Growth on original stand[a]	300	87.9
Ingrowth	149	14.4
Total growth	449	102.3
Mortality	52	11.6
Net growth	397	90.7
Cutting drain	163	38.4
Net change in growing stock	+234	+52.3
Growing stock, Jan. 1, 1948	10,258	2,371.7

[a] Growth on trees included in the growing stock at the beginning of the year.

Table 24. — Average Annual Net Board-Foot Growth by Species, Expressed as a Percentage of Saw-Timber Inventory Volume

Species	Growth on original stand less mortality[a]	Ingrowth	Net growth
		percent	
White oak	2.11	.89	3.00
Black oak	1.89	.64	2.53
Northern red oak	2.48	.71	3.19
Post-oak group	1.96	.57	2.53
Other red oaks	2.64	1.90	4.54
Elm	2.79	2.31	5.10
Hickory	1.72	.62	2.34
Soft maple	3.22	1.60	4.82
Sycamore	2.84	.37	3.21
Cottonwood	5.39	.26	5.65
Ash	2.17	.88	3.05
Basswood and yellow-poplar	2.47	.37	2.84
Other species	3.11	6.06	9.17
All species	**2.48**	**1.49**	**3.97**

[a] Annual growth on trees included in the saw-timber growing stock at the beginning of the year less annual mortality losses.

Ingrowth has proportionally less effect on the net growth of the total growing stock than on that of saw timber. Sixteen percent of the net growth on total growing stock is accounted for by cubic-foot ingrowth. Total cubic volume on which the ingrowth percentage is based includes the pole-timber volume as well as the saw-timber volume. The volume of small trees annually reaching minimum pole-timber size is much less than the volume of ingrowth into the saw-timber class.

Mortality losses, which are deducted from total growth to obtain net growth, include losses due to all natural causes such as fire, insects, disease, wind, drouth, and tree competition. The average annual board-foot mortality amounts to 0.52 percent of the volume in the saw-timber growing stock. Annual cubic-foot mortality amounts to 0.50 percent of the volume in the total growing stock.

Net saw-timber growth by log grade. The Survey field studies of growth did not include a breakdown of saw-timber growth by log grade. However, this was estimated to make possible rough comparisons of growth and drain by quality class. The following estimates of growth by grade include only the growth of hardwood saw timber. Since softwoods comprise less than one-half of 1 percent of the total volume of saw-timber growing stock in Illinois, no attempt was made to estimate the log grades of either the volume of growing stock or of growth for the softwood species.

During 1947 the net growth of high-quality (grades 1 and 2) hardwood saw timber totaled 97 million board feet or about 25 per-

cent of the net saw-timber growth. The remaining 75 percent of the volume of 1947 net saw-timber growth, 300 million board feet, was of log grade 3, the lowest quality class.

The 97 million board feet of high-quality growth was further broken down according to general species groups used by a number of specific forest-products industries. White oaks and red oaks each accounted for about 25 million board feet. The soft hardwoods species, such as cottonwood, sycamore, sweetgum, elm, and soft maple, which are used by the container veneer industry, totaled an estimated 30 million board feet of high-quality growth. The remaining 17 million board feet was made up of all other hardwood species combined.

The volume of high-quality ingrowth from small trees which grew large enough during the year to produce logs of grades 1 and 2 totaled an estimated 38 million board feet, or about 40 percent of the total board-foot volume of high-quality net growth.

Net growth per acre. The average volume of net growth per acre varies considerably among stands, depending upon such factors as site productivity, species and tree-size composition, and especially the density of stocking. The 1947 net growth on the saw-timber growing stock averaged about 101 board feet per acre for the entire state and varied little among regions (Table 25). The 1947 net growth on the total growing stock averaged 23 cubic feet per acre throughout the state, and averaged slightly higher in the Southern region than elsewhere chiefly because the volume of growing stock per acre averages the highest in this region.

Table 25. — Average Growth per Acre by Physiographic Region, 1947

Region	Growth on original stand[a]	Ingrowth	Mortality	Net growth
Saw-timber growing stock				
		board feet		
Prairie	78.3	33.4	12.7	99.0
Claypan	73.3	43.7	13.6	103.4
Southern	76.7	37.2	13.4	100.5
State	**76.2**	**37.9**	**13.2**	**100.9**
Total growing stock				
		cubic feet		
Prairie	21.0	2.9	2.9	21.0
Claypan	21.5	3.8	2.9	22.4
Southern	25.3	4.7	3.1	26.9
State	**22.3**	**3.7**	**3.0**	**23.0**

[a] Growth on trees included in the growing stock at the beginning of the year.

The present volume of net growth, both board-foot and cubic-foot, is far less than the potential growth primarily because of understocking. By adequate protection of the forest areas, especially from grazing, and by good forest management practices, both rate of growth and volume of growing stock could be increased and the annual volume of net growth could conceivably be doubled or tripled. Such a volume of growth would provide a sustained timber supply for a greatly expanded forest-products industry.

FOREST-PRODUCTS INDUSTRIES

Wood is used in the production of thousands of different products. Complete enumeration of the Illinois industries that use wood as a raw material is therefore extremely difficult, and only a general description by broad classifications can be presented here.

Illinois ranks high nationally in the manufacture of wood products. According to the 1947 Census of Manufactures Illinois ranks first among the states in the production of mirror and picture frames, window shades, and wooden cooperage such as barrels, kegs, tubs, and other containers made of staves; ranks second in the production of miscellaneous wood products, and of all types of furniture combined; also ranks second in wood preserving; ranks fourth in the production of wooden containers of all kinds combined, and of venetian blinds; and ranks fifth in the production of wood millwork such as flooring, sash, windows, doors, moldings, panel work, stairways, and similar fabricated products.

The present wood requirements of Illinois are estimated to total from 1½ to 2 billion board feet annually, of which 90 to 95 percent is imported. Roughly three-fourths of the wood consumed in Illinois is of softwood species, practically all of which is imported since the local forests contain scarcely any softwoods. The state also imports 70 to 75 percent of its hardwood requirements.

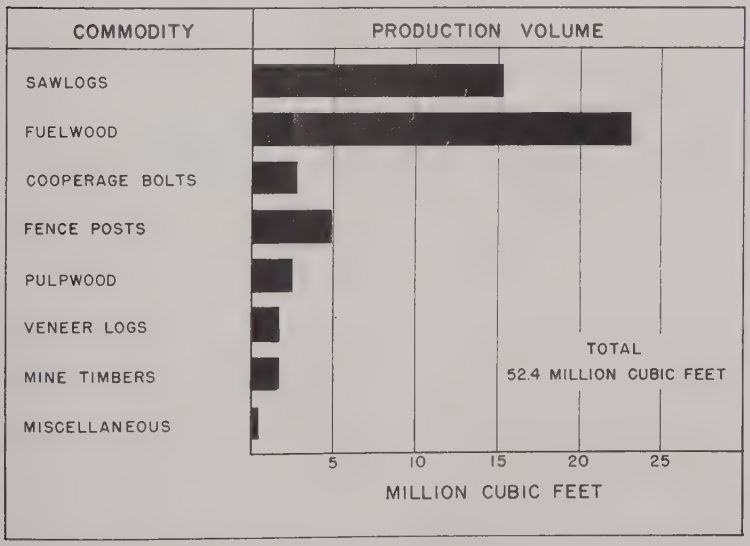
Although Illinois probably never can produce enough softwood timber to meet the softwood requirements of its industries, the state could easily produce a sustained volume of hardwoods that would more than meet present hardwood requirements. The timber stands on the present forest area could be built up to provide a sustained harvest of possibly seven times the present annual cut (page 68). Any increase in forest area through the restoration of forest cover on unforested lands best suited for timber production would provide additional timber. The opportunities for the state to become more self-

sufficient in meeting its own timber requirements will be discussed later in more detail.

The forest-products industries are normally divided into two general groups (**1**) primary forest-products industries — those producing the first marketable products from the forest, such as sawmill products, hewn timbers, veneer, staves and heading, pulpwood, and miscellaneous logs and bolts; and (**2**) secondary forest-products industries — those processing the wood beyond the above stages. Since a number of industries may operate in both primary and secondary capacities, there is some overlapping and specific classification sometimes cannot be made.

Primary Forest-Products Industries

Approximately 1,200 primary forest-products plants in the state drew timber from the Illinois forests during 1947. An estimated 863,000 man-days of woods labor (Table 26), the equivalent of full-time employment for 3,450 men, was required during 1947 to harvest and transport roughly 52.4 million cubic feet of Illinois logs, bolts, and billets valued at more than 12 million dollars (Table 27). An additional



Production of primary forest products in Illinois, 1947. **(Fig. 25)**

Table 26. — Employment in the Primary Forest-Products Industries, 1947[a]

Commodity	Total	Woods[b]	Plant[c]
	thousand 8-hour man-days		
Lumber	299	129	170
Fuelwood	478	478	..
Cooperage stock	113	61	52
Fence posts	105	105	..
Pulpwood	69	39	30
Veneer	94	23	71
Mine timbers	21	21	..
Miscellaneous[d]	10	7	3
Total	**1,189[e]**	**863**	**326**

[a] Calculated by the authors through application of labor factors per unit of production to total production.
[b] Labor expended in harvesting and transporting all logs and bolts cut in the state.
[c] Labor expended in Illinois plants in processing only the wood from the Illinois forest. Does not include labor expended in processing wood imported from other states or countries.
[d] Charcoal, piling, handles, and miscellaneous farm timber products.
[e] Equivalent of full-time employment (fifty 40-hour weeks a year) for 4,750 men.

326,000 man-days (1,300 man-years) was expended in the Illinois primary forest-products plants to further process a portion of this Illinois timber into primary products such as rough lumber, rough staves, veneer, handles, and containers. Sawlogs made up 29 percent of the 1947 volume of all primary forest products cut in the state (Fig. 25). Fuelwood accounted for 44 percent of total production, fence posts for about 9 percent, and the remaining 17 percent was made up of a number of products, chiefly tight cooperage stock, pulpwood, veneer logs, and mine timbers (Table 27).

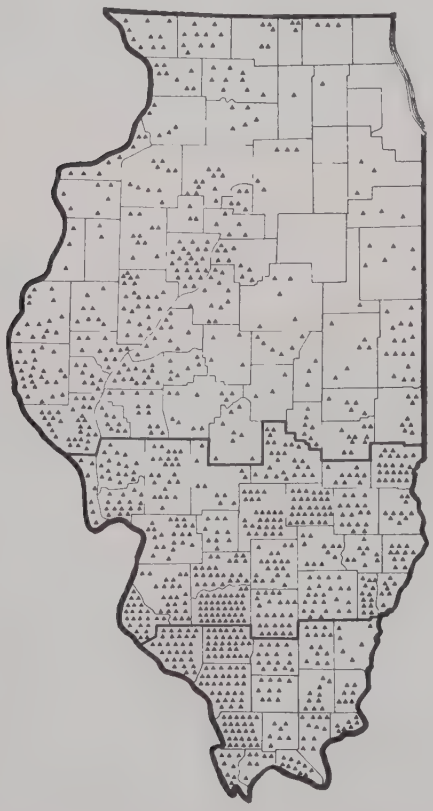
Table 27. — Volume and Value of Primary Forest Products by Commodity and Source of Material, 1947[a]

Commodity	Unit of measure	Production from Illinois growing stock	Production from Ill. nongrowing stock[b]	Total production from all Illinois material	Total production from all Illinois material		Value[c]
					thousand cu. ft.	*percent*	*dollars*
Lumber	M bd. ft. (lbr. tally)	99,764	(d)	99,764	15,348	29.3	3,491,750
Fuelwood	Std. cords	159,505	207,811	367,316	23,163	44.2	3,305,850
Cooperage	M bd. ft. (Int'l)	17,367	(d)	17,367	2,672	5.1	1,389,350
Fence posts	M pieces	3,686	4,748	8,434	4,903	9.4	2,108,450
Pulpwood	Std. cords	36,134	2,651	38,785	2,443	4.7	387,850
Veneer	M bd. ft. (Int'l)	11,324	(d)	11,324	1,742	3.3	711,800
Mine timbers	M cu. ft.	1,702	(d)	1,702	1,702	3.2	510,700
Miscellaneous[e]	M cu. ft.	318	85	403	403	.8	101,700
Total		.....	.....	.....	**52,376**	**100.0**	**12,007,450**

[a] Production from Illinois material in Illinois and in other states.
[b] Dead trees, scattered nonforest trees, by-products, cull trees, etc.
[c] Value of logs, bolts, and billets, f.o.b. local delivery point. (Compiled by authors from various sources.)
[d] Negligible.
[e] Charcoal wood, piling, handle bolts, and miscellaneous farm timber products.

Lumber

Very little lumber was produced in Illinois before the nineteenth century. Beginning about 1839, great quantities of pine logs were floated from the Lake States to Illinois sawmills located along the Mississippi river and the Lake Michigan shoreline. Sawmilling activity in Illinois increased constantly throughout the century and reached a peak about 1900 with an annual lumber production of 388 million board feet, of which about one-third was from imported pine logs. Shortly after the turn of the century, imports of finished lumber from



Location of active sawmills in Illinois, 1947. (*Source: U. S. Bureau of the Census.*) (Fig. 26)

other states increased, while imports of softwood logs decreased. Lumber production of the Illinois sawmills dropped rapidly to about 42 million board feet in 1918, and then fluctuated between 40 and 65 million annually until 1932, when it dropped to a record low of about 30 million board feet.[1] Annual lumber production increased slowly and rather constantly through the depression and war years. In 1947, according to the U. S. Bureau of the Census, 100 million board feet of lumber was produced in Illinois. Almost two-thirds of this lumber was of various oak species; softwoods made up less than 1 percent of the total volume.

In 1947 the sawmills in Illinois numbered 1,530, of which 1,155 were active during the year (Table 28 and Fig. 26). Most Illinois

Table 28. — Number of Sawmills and Lumber Production by Mill-Production Class, 1947[a]

Mill-production class according to annual production in thousands of bd. ft. lumber tally	Mills		Production	
	Number	Percent	Thousand bd. ft.	Percent
Active:				
1-49	715	47	11,822	12
50-499	401	26	51,247	51
500-999	30	2	20,292	20
1,000 plus	9	1	16,403	17
Total active	1,155	76	99,764	100
Idle	375	24	.....	...
Total	**1,530**	**100**	**99,764**	**100**

[a] Source: Bureau of the Census, U. S. Department of Commerce.

sawmills are portable, circular mills, many of them more or less permanently set up. Several band-saw mills are located in the southern and eastern parts of the state. Many of the 375 idle mills are badly in need of repairs and probably should be classed merely as scrap iron.

The active mills were divided into production classes on the basis of annual lumber production (Table 28). Seven hundred fifteen mills — 47 percent of the total number in the state — each produce less than 50,000 board feet of lumber annually (Fig. 27). Most mills in this group are small farm mills, badly worn, poorly equipped, and capable of producing only low-quality lumber, most of which is used locally on farms. They operate but a few days each year and produce about 12 percent of all lumber cut in the state.

The backbone of the lumber industry in Illinois is the 401 small mills in the group that produce from 50,000 to 499,000 board feet

[1] STEER, HENRY B. Lumber production in the United States 1799-1946. U. S. Dept. Agr. Misc. Publ. 669, p. 16. 1948.

Sawmills that produce less than 50,000 board feet of lumber annually are generally poorly equipped and capable of producing only low-quality lumber. Most of this lumber is used locally on farms. (Fig. 27)

annually (Fig. 28). This group includes 26 percent of all the mills and produces 51 percent of the total lumber cut. In general, these mills are underpowered and poorly equipped. Most of the lumber they produce is used locally in rough form or is sold to concentration yards for

Half of all lumber produced in Illinois is cut by small sawmills whose yields range individually from 50,000 to 499,000 board feet of lumber annually. (Fig. 28)

finishing and grading. Many of them operate intermittently in order to use part-time farm labor. Often a single crew alternates between logging and milling. Many of these mills are moved frequently to eliminate long truck hauls; logs often are skidded directly to the mills located in or near the forest. Some mills engaged primarily in custom-sawing are permanently located on the operator's land. In such cases, the customer usually delivers the logs and hauls off the rough lumber.

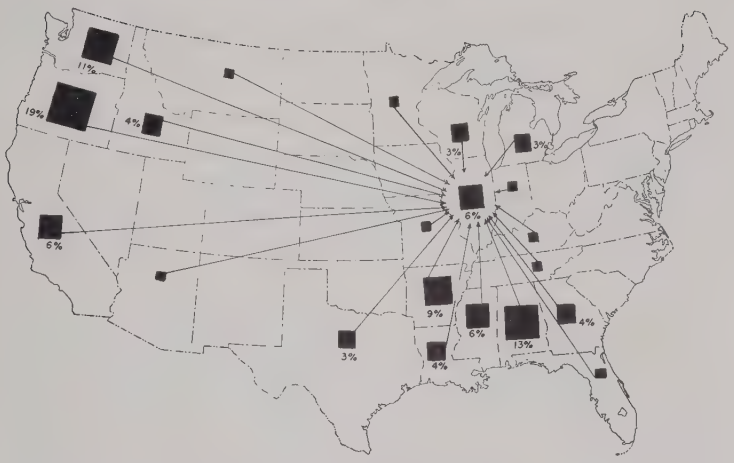
The 30 sawmills in the class that produces annually from 500,000 to 999,000 board feet of lumber make up 2 percent of the total number of mills and produce 20 percent of the total lumber cut. Most of these mills operate throughout the year. The smaller mills in this class operate in much the same manner as those described in the preceding paragraph. The larger ones are generally well equipped and efficiently operated. They are well set up and are seldom moved. Logs generally are hauled to these mills by truck, and many logs are purchased on the mill site from local timber owners.

Nine mills in Illinois each produce a million board feet or more of lumber annually. Although they represent less than 1 percent of the total mills, they produce 17 percent of all lumber cut in the state. For the most part they are permanently located and well equipped, and their output is well manufactured, seasoned, and graded.

Practically all timber processed by Illinois sawmills comes from forests within the state. The value of the sawlogs consumed by these mills during 1947 totaled 3.5 million dollars, f.o.b. the mill. The lumber produced that year was valued at roughly 5.5 million dollars, f.o.b. the mill, in rough, green form. About 300,000 man-days, the equivalent of full-time employment for 1,200 men, were required to produce this rough lumber from the standing timber. Although much of the lumber was consumed locally in this form, further finishing and grading of the remainder added substantially to the final value of the total lumber output.

No recent information is available on the distribution of lumber produced in Illinois. However, according to a 1943 study made co-operatively by the U. S. Forest Service and the U. S. Bureau of the Census, only 11 percent of the lumber produced in the state is shipped outside the state; most of this goes to Indiana and Missouri.

According to the same study, Illinois imports 94 percent of its lumber requirements. Illinois sawmills produce only 26 percent of the hardwood lumber and practically none of the softwood lumber requirements of the state. The bulk of the lumber shipped in consists of



Sources of the lumber consumed in Illinois in 1943. **(Fig. 29)**

softwood construction materials from Oregon, Washington, California, and the southern states (Fig. 29).

Fuelwood

More local wood is used for fuel in Illinois than for any other purpose. During 1947 about 367,000 standard cords of fuelwood was produced — practically all of it cut from farmer-owned lands. Roughly 25 percent of the total volume was produced from red oaks, 20 percent from white oaks, 15 percent from hickory, and the rest from all other species combined.

Fuelwood makes up 44 percent of the total volume of wood in all primary forest products produced in Illinois. However, since about 60 percent of all fuelwood is produced from dead trees, saw-timber tops, scattered nonforest trees, and from materials salvaged from cutting operations for other products, fuelwood represents only 24 percent of the total cutting drain on the forest growing stock. Fuelwood was produced from the materials listed at the top of page 58.

Most fuelwood is produced by farmers for home consumption at no cost other than the labor expended. Roughly 478,000 man-days of labor, the equivalent of full-time employment for 1,900 men, are expended annually on fuelwood production. On the basis of 1947 prices, the value of this fuelwood is estimated at 3.3 million dollars.

Source of fuelwood	Thousand standard cords	Percent of total production
Saw-timber trees	44	12
Pole-timber and sapling trees	115	31
Total growing stock	159	43
Dead trees	53	14
By-products	65	18
Total from commercial forest land	277	75
Nonforest (fence rows, scattered trees, etc.)	90	25
Total 1947 fuelwood production	367	100

Cooperage stock

Illinois leads the nation in the production of barrels, kegs, tubs, and other containers made of wooden staves. Most of the total output is slack cooperage. At present, all stock used by the Illinois slack-cooperage plants is imported, primarily from the southern and southeastern states.

About 20 tight-cooperage stave mills operated in Illinois during 1947. They consumed more than 17 million board feet of Illinois saw timber (1.4 million dollars' worth), practically all of which was high-quality white oak (Fig. 30). About 15 million board feet of this tight-cooperage stock was exported to secondary plants in nearby states for

Practically all the 17 million board feet of Illinois timber cut by tight-cooperage stave mills during 1947 was of high-quality white oak. (Fig. 30)

final processing into containers. An estimated 113,000 man-days of Illinois labor, full-time employment for 450 men, were required to convert the standing timber into rough staves and heading.

Fence posts

A tremendous number of wooden fence posts is needed annually to maintain the thousands of miles of fence in the state. Many wooden posts are imported from other states; imports are chiefly redcedar posts from Missouri, Arkansas, and Tennessee; white cedar from Wisconsin and Minnesota; and some treated yellow pine from Missouri and the southern states.

Roughly 8.5 million fence posts, valued at more than 2 million dollars, were produced in Illinois during 1947. About half of the posts produced in Illinois are of Osage-orange cut from hedges on nonforest lands and therefore are not included in the volume of drain on the forest growing stock. About 30 percent of all posts produced locally are cut from white oaks, 15 percent from black locust, and the remaining 5 percent from other species. Following is a breakdown of fence post production by source of material:

Source of material	*Thousand posts*	*Percent of total production*
Saw-timber trees	1,543	18.3
Pole-timber and sapling trees	2,143	25.4
Total growing stock	3,686	43.7
Dead trees	273	3.2
By-products	9	.1
Total from commercial forest land	3,968	47.0
Nonforest (fence rows, scattered trees, etc.)	4,466	53.0
Total 1947 fence post production	8,434	100.0

Practically all fence posts are produced by farmers from their own lands. Approximately 105,000 man-days of Illinois labor, the equivalent of full-time employment for 420 men, were expended in 1947 to produce fence posts.

Pulpwood

During 1947 about 39,000 standard cords of pulpwood, valued at $388,000, f.o.b. the local delivery point, were harvested from the Illinois forests. This pulpwood consisted chiefly of bottomland hardwood species, such as cottonwood, soft maple, and willow. Almost 90 percent of the total volume was cut from pole-timber trees, generally in clear-cutting operations. The remaining 10 percent was produced

from saw-timber trees and from materials salvaged from logging operations for other commodities. An estimated 69,000 man-days of labor were expended in the state in harvesting and processing pulpwood from the Illinois forest.

Most of the pulpwood produced during 1947 — 30,000 cords — was shipped to five local felt mills where it was converted into such products as asphalt roofing and various types of building and insulating felts. The remaining 9,000 cords were shipped to paper pulp mills outside the state. No paper pulp mills in the state consume local timber.

Veneer

More than 11 million board feet of veneer logs, valued at $712,000, were harvested during 1947 from Illinois forests. About 94,000 man-days of Illinois labor, the equivalent of full-time employment for 375 men, were required to harvest this timber and process a portion of it into finished products. Of this volume, 1 million board feet were used for the production of high-quality face veneer used mainly in furniture manufacture. The remaining 10 million board feet were used to produce rotary-cut container veneer by plants in Illinois and the adjacent states (Fig. 31).

More than 10 million board feet of Illinois timber is cut into container veneer each year. (Fig. 31)

Only two plants in the state produced finished face veneer from local timber. However, in 1947 at least 11 additional plants in the surrounding states, chiefly in Indiana, bought Illinois timber for face veneer. Since that date several additional veneer plants have begun to buy logs in Illinois. Most face-veneer logs produced in Illinois are black walnut, although some other species such as white oak and yellow-poplar are used to some extent.

Nine companies in southern Illinois manufacture veneer containers entirely or partly from Illinois-produced wood. Seven of these companies convert standing trees or parts of them into fruit and vegetable containers, meat and poultry boxes, industrial crates, egg cases, dirt bands, tree wrappers and mats, basket handles, shingle boards, and other similar items. One company produces veneer for other companies to assemble, and one buys custom-cut veneer for assembly.[1] About 1.4 million board feet of Illinois logs are exported annually to container veneer plants in adjacent states.

Of the more than 10 million board feet used for container veneer each year, 60 percent is cottonwood, 12 percent sycamore, 10 percent sweetgum, and the remaining 18 percent is other species, chiefly yellow-poplar, elm, and soft maple.

Mine timbers

Illinois ranks fourth nationally in coal production. During 1947 Illinois coal production exceeded 68 million tons, roughly three-fourths of which was produced from underground mines. The rest was produced from open strip mines which used no round mine timbers. All wood used in the strip mines is sawn material, which in this report is classified as lumber.

The underground coal mines in Illinois required about 6 million cubic feet of round mine timbers and hewn mine ties during 1947 in addition to a large volume of sawn timbers which is not included in the above figures since sawn materials are classified as lumber.[2] Most of this volume consisted of mine props, posts, and legs used to support the mine roof. Although usually sawn, some round mine bars (roof timbers) are used and the volume of unsawn bars is included in the volume of round mine timbers. Sawn mine ties are excluded, but those simply hewn flat on two sides are included. Other sawn materials used

[1] WALTERS, C. S. The Illinois veneer container industry. Ill. Agr. Exp. Sta. Bul. 534, 1949. Volumes presented here are those from Bulletin 534 converted to International log scale.

[2] Statistics for 1948 may be obtained from "Hardwood Requirements of the Illinois Coal-Mining Industry," by C. S. Walters. Ill. Agr. Exp. Sta. Bul. 554, 1952.

by the mines such as capboards, header blocks, and wedges are sawmill products and are not included in the volume of round mine timbers.

About 1.7 million cubic feet of mine timbers and mine ties, valued at more than $500,000, were harvested during 1947 from the Illinois forests. Roughly 90 percent of this volume consisted of various oak species and the rest included several other hardwoods, primarily hickory. This volume of local timber made up less than one-third of all mine timbers and hewn mine ties required by the Illinois coal mines during that year. The remaining volume was imported, chiefly from Missouri, with small volumes from Wisconsin and Michigan.

Before World War II, a much larger proportion of the timber used by the Illinois mines was produced locally. During the war, mainly because of over-all manpower shortages, the local producers were unable to meet the mine-timber requirements of the Illinois mines for current consumption and some stock-piling. Imports were increased substantially to supply the mines' requirements. The present trend in the buying pattern is back toward increased use of local timber. A number of mines that imported large volumes of mine timbers during the war and immediate postwar years are now operating primarily on local timber.

Miscellaneous products

Smaller volumes of Illinois timber are harvested for several minor wood commodities. During 1947 the three charcoal plants operating in the state used more than 2,300 standard cords of local wood. Three Illinois handle plants drew more than 33,000 cubic feet of handle bolts from the Illinois forest during the same year. Roughly one-half of this volume was ash, and the rest consisted about equally of hickory and oak.

The number of poles and piles produced in Illinois is relatively insignificant. All poles used in the state, other than a few occasionally cut by farmers for home use, are imported chiefly from the southern states. Practically all piling used in building construction and in river and harbor installations is also imported. Only about 98,000 cubic feet of piling was produced during 1947 from the Illinois forests. An additional 122,000 cubic feet of local timber was harvested for rough farm constructions, such as corrals, log sheds, gates, and pole fences. The combined volume of these minor products totaled approximately 400,000 cubic feet, was valued at more than $100,000, and required approximately 10,000 man-days of labor to produce.

Secondary Forest-Products Industries

The secondary forest-products industries remanufacture such primary products as lumber, bolts, flitches, and dimension stock into finished or semifinished wooden products. This group of industries does not include those in the field of chemical wood conversion that manufacture products such as pulp, paper, rayon, plastics, and chemical derivates. Nor does it include the large number of establishments engaged in building construction.

The 1947 Census of Manufactures, conducted by the Bureau of the Census, U. S. Department of Commerce, is the most recent intensive survey of the secondary forest-products industries in Illinois. This 1947 Census lists 999 Illinois establishments engaged in the remanufacture of wood. The value added to the wood by converting it into finished or semifinished products amounted to more than 200 million dollars. During 1947 the secondary forest-products industries provided jobs for more than 41,000 people, or more than eight times the number needed to produce the primary forest products cut in Illinois. Combined salaries and wages of employees of the secondary industries totaled approximately 117 million dollars. Table 29 shows a breakdown of the 1947 Census data for wood-remanufacturing industries by major industry groups.

Almost three-fourths of all Illinois secondary forest-products industries are located in Chicago and its suburbs. Smaller concentrations of such industries are located in Rockford, which has long been a famous furniture-manufacturing center, and in Elgin, East St. Louis,

Table 29. — Number of Establishments and Number of Employees in Each Major Group of the Illinois Wood-Remanufacturing Industries; Salaries and Wages; and Value Added Through Manufacture, 1947

Industry group	Number of establishments	Number of employees (average for year)	Salaries and wages (thousand dollars)	Value added through manufacture (thousand dollars)
Millwork and related products	152	4,248	13,712	19,570
Wooden containers	86	3,183	7,198	11,771
Miscellaneous wood products	177	4,200	11,479	21,913
Household furniture	335	19,895	54,707	90,983
Office furniture	21	1,633	4,544	8,419
Public and professional furniture	24	1,534	4,546	6,949
Partitions and fixtures	83	3,002	9,373	17,268
Screens, shades, and blinds	95	3,003	8,903	19,571
Miscellaneous furniture and fixtures	26	766	2,524	3,763
Total	999	41,464	116,986	200,207

Peoria, and Kankakee. Many other important wood-remanufacturing plants are scattered throughout the state.

According to a recent survey by the Forest Service, the wood used by Illinois manufacturing industries during 1948 totaled 698 million board feet. Hardwoods made up nearly 45 percent of this total, or 311 million board feet, most of which was imported from other states. These local industries provide a great potential market for the additional volume of hardwoods that could be grown in Illinois through the development and improved management of lands best suited to forestry.

Cutting Drain on the Forest Growing Stock

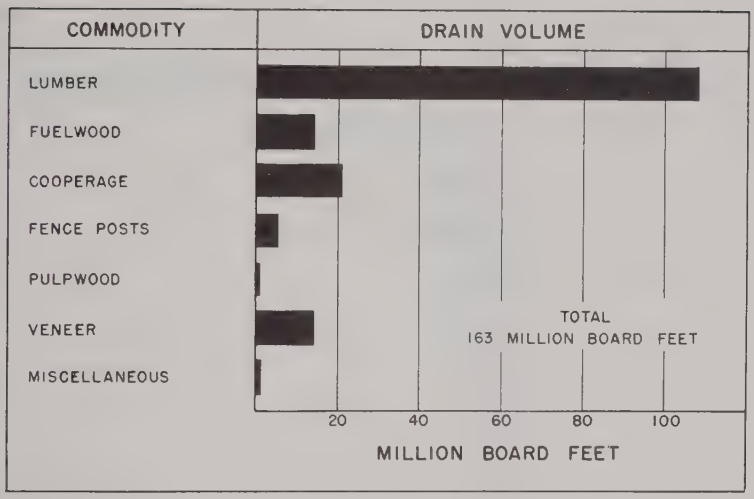
Cutting drain includes the volume removed from the Illinois forest growing stock for processing in other states as well as in Illinois. It includes both the materials utilized and the volume destroyed but not utilized in harvesting and processing. It does not, however, include the volume of nongrowing-stock materials consumed, such as wood from dead trees, from scattered trees on nonforest areas, from saw-timber tops, and from cull trees.

Drain on the saw-timber growing stock

The 1947 cutting drain on the Illinois saw-timber growing stock totaled 163 million board feet (Table 30). About two-thirds of this volume was cut for lumber, 13 percent for tight cooperage, 8 percent each for fuelwood and veneer, and the remaining 5 percent was distributed among all other primary forest products (Fig. 32). Approximately one-half of the saw-timber drain was on various oak species; cottonwood, hickory, and elm made up about 6 percent each, and the remaining 32 percent consisted of other hardwoods. The

Table 30. — Cutting Drain on the Saw-Timber Growing Stock by Commodity, 1947

Commodity	Volume	
	thousand bd. ft.	*percent*
Lumber	108,180	66.3
Fuelwood	13,679	8.4
Cooperage	20,849	12.8
Fence posts	5,506	3.4
Pulpwood	545	.3
Veneer	13,595	8.3
Miscellaneous	851	.5
Total	**163,205**	**100.0**



Cutting drain on the saw-timber growing stock, by commodity, 1947. (Fig. 32)

volume of softwood species harvested annually in Illinois is relatively insignificant. Roughly 30 percent of the saw-timber drain was on the forests of the Prairie region, and about 35 percent each on those of the Claypan and Southern regions.

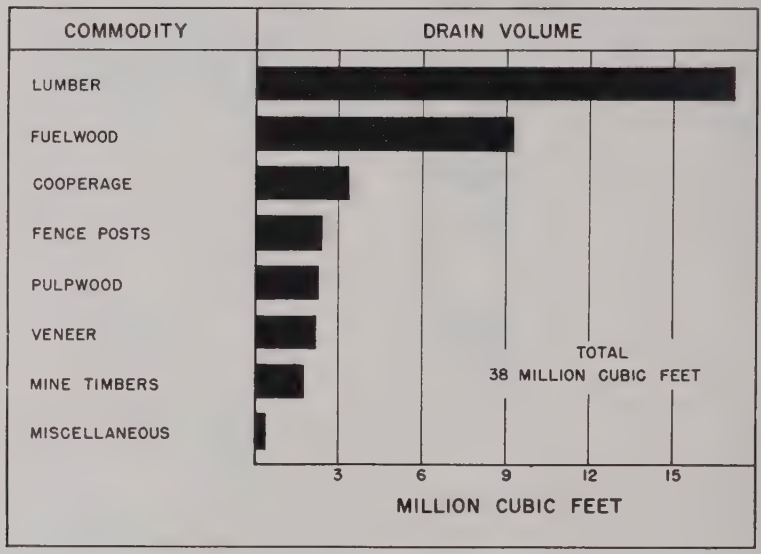
Drain on the total growing stock

The 1947 cutting drain on the total growing stock, saw timber and pole timber combined, totaled 38 million cubic feet (Fig. 33). Lumber

Table 31. — Cutting Drain on the Total Growing Stock by Commodity, 1947

Commodity	All timber		Saw-timber trees	Pole-timber trees
	thousand cu. ft.	*percent*	*thousand cubic feet*	
Lumber	17,172	44.7	16,989	182
Fuelwood	9,271	24.2	2,104	7,167[a]
Cooperage	3,274	8.5	3,274	.....
Fence posts	2,251	5.9	847	1,404[b]
Pulpwood	2,245	5.9	84	2,161
Veneer	2,135	5.6	2,135	.....
Mine timbers	1,702	4.4	(c)	1,702
Miscellaneous	325	0.8	132	193[d]
Total	**38,375**	**100.0**	**25,566**	**12,809**
Percent of total	*100.0*	.....	*66.6*	*33.4*

[a] Includes 2,168 thousand cubic feet from saplings.
[b] Includes 320 thousand cubic feet from saplings.
[c] Negligible.
[d] Includes 27 thousand cubic feet from saplings.



Cutting drain on the total growing stock, by commodity, 1947. (Fig. 33)

production accounted for 45 percent of the total volume, fuelwood for 24 percent, tight cooperage for 8 percent, fence posts for 6 percent, and all other commodities combined for the remaining 17 percent (Table 31). Approximately two-thirds of the total cutting drain on the forest growing stock is on saw-timber trees. The total cutting drain is distributed by physiographic regions in approximately the same proportions as is the saw-timber drain.

Drain by log grade

During 1947 about 93 million board feet of hardwood saw-timber drain was of low quality (log grade 3). The remaining 70 million board feet, or more than 40 percent of the total hardwood saw-timber drain, was in log grades 1 and 2. Of this amount, about 24 million was of white oaks, 17 million of red oaks, 24 million of soft hardwoods, and the remaining 5 million of all other hardwood species combined.

Saw-timber drain in relation to stand volume, especially of grades 1 and 2, is heaviest in the Southern region. Although only 25 percent of the Illinois saw-timber growing stock is located in the Southern region, it supported roughly 35 percent of the total 1947 saw-timber

drain in the state and 40 percent of the grades 1 and 2 saw-timber drain. The high-quality saw-timber drain in the Southern region totaled an estimated 27 million board feet, which consisted of about 8 million of white oaks, 7 million of red oaks, 11 million of soft hardwoods, and 1 million board feet of all other species combined.

TRENDS IN TIMBER VOLUME AND STAND COMPOSITION

Since there are no estimates of the timber resources of Illinois for previous years that are comparable to the Forest Survey statistics for 1947, net growth and cutting drain have been compared to measure the over-all effect of wood utilization on the Illinois forest growing stock. To gain the greatest possible revenue from forest lands, net growth and drain should balance at as high a level as practicable, considering site limitation and optimum land use. If returns are to be sustained over a long period of time, the volume harvested must not exceed the volume of net growth. If an appreciably greater volume of growth is to be realized on the Illinois forest lands, the volume of growing stock must be increased. This volume can be increased each year only by the amount that net growth exceeds the cutting drain.

A comparison of net growth and cutting drain for any single year generally cannot be regarded as a reliable index of growing stock trends. The loss in inventory volume during a single year or possibly even several consecutive years of extremely high production, during which drain greatly exceeds net growth, can be counterbalanced by another period of surplus growth. Other factors, such as extremely heavy fire losses and unpredictable epidemics of insects or disease, can greatly affect the growth-drain balance for a short period. During the two decades following the first World War, the annual volume of drain in Illinois was somewhat lower than at present. However, the volume of drain in 1947 is believed to be a reasonably good estimate of the average annual drain for the past 8 to 10 years. The 1947 drain, therefore, can be used to indicate the current trend of the forest growing stock.

Current Growth-Drain Balance

The volume of saw-timber growing stock in Illinois is increasing. If 1947 is assumed to be typical of recent years, the volume of net growth exceeds the volume of cutting drain on the saw-timber growing stock by 234 million board feet each year (Table 24). This surplus

of growth over drain increases the volume of saw-timber growing stock about 2.3 percent annually. The volume of total growing stock (saw timber and pole timber combined) is also increasing 2.3 percent annually, with the annual volume of net growth exceeding that of cutting drain by 52 million cubic feet.

Several points must be considered in interpreting the significance of these current trends. These points are discussed in the following paragraphs primarily from the standpoint of saw-timber growing stock, but they apply in general to the total growing stock as well.

Although the current growth-drain balance for the state as a whole is very favorable and the volume of growing stock is constantly increasing, the returns from the forest land are still far less than the maximum attainable. That is because both the volume of growth and the volume of drain are low. The present forest area could probably produce three times as much net growth as it does at present. A balance between growth and cutting drain would then sustain an annual harvest of forest products about seven times that taken from the Illinois forest growing stock during 1947. To attain such a volume of growth, the forest growing stock must be built up to an optimum average volume of 7,000 to 8,000 board feet per acre. At the present rate of increase, it would take about 80 years to reach this goal. But with improved management, primarily better cutting practices coupled with improvement cuts, optimum stocking could be reached in less time.

The over-all growth-drain balance for the state is an average which does not indicate the variations in forest conditions that exist among specific localities. The serious overcutting that is taking place in many areas is masked by growth surpluses in others. Although the timber operators in some areas are hampered by the lack of suitable stumpage, many other areas in the state support heavy timber stands that are actually in need of cutting. As was previously pointed out (Fig. 22), 66 percent of the commercial forest area supports only 21 percent of the total saw-timber volume. More than half of the saw-timber volume is concentrated on 18 percent of the forest area; 36 percent of the volume is located on 9 percent of the forest area. The stands on many of these heavily stocked areas contain large volumes of mature and overmature timber that should be harvested. Proper harvesting of such timber could improve these stands silviculturally and at the same time provide high-quality timber to meet industrial needs. If the annual cut were properly distributed over the entire forest area, the volume of Illinois timber harvested annually could be substantially

increased without a corresponding reduction in the present surplus of growth over drain.

Another factor to be considered is that the over-all growth-drain balance does not indicate changes in the quality, nor in the species and tree-size composition of the stand. Cutting drain in Illinois is now concentrated on trees of better-than-average quality, trees of favored species, and — at least in many localities — on the larger trees. Growth, on the other hand, is distributed over trees of all species, sizes, and quality — including the less desirable ones. As a result, stands are deteriorating in many areas.

Stand deterioration is more common in the Southern region than elsewhere in Illinois. For all species and log grades combined, the 1947 saw-timber drain in this region totaled about 56 percent of the saw-timber growth, as compared with 41 percent for the entire state. For all species combined, but considering only the high-quality logs, the 1947 saw-timber drain is roughly estimated to be 130 percent of growth in the Southern region as compared with 72 percent for the state. Accordingly, the growth of high-quality logs appears to be overcut in the Southern region, although this deficit is more than compensated for by a surplus of high-quality growth over drain in the northern two regions.

The overcut of high-quality growth in the Southern region during 1947 occurred chiefly in the white oaks and the soft hardwood species. High-quality growth in red oaks and in hard hardwoods other than the white oaks exceeded high-quality drain. Although high-quality growth was overcut in many local areas throughout the state, the over-all 1947 state balances of grades 1 and 2 growth and drain were favorable for each of the species groups mentioned above.

Past Growth-Drain Balance

Available data on the past growth-drain balance indicate that the annual volume of drain on Illinois timber was greatest during the years of extensive land clearing before the Civil War. Much of the timber then was destroyed and not utilized. Heavy cutting drain continued throughout the century, with more timber being used for forest products, primarily lumber. Production of lumber reached its peak by the end of the century, and then dwindled rapidly. Shortly after this period of heavy logging, at about the time of the first World War, the volume of standing saw timber in Illinois was probably the smallest in the history of the state.

The annual volume of cutting drain remained relatively low in the

following two decades. During this period net growth exceeded drain partly because of the low volume of annual cut and partly because of the large volume of ingrowth in young trees that were released during the period of heavy logging and were then reaching saw-timber size. Today 46 percent of all saw-timber volume is in trees of less than 17 inches d.b.h., practically all of which were too small to be included in the saw-timber volume in 1910.

During the decade immediately preceding 1947, the average annual volume of drain was greater than at any other time since the first World War. However, the volume of growing stock was also greater and the volume of growth still exceeded drain. The annual growth-drain balance during the last decade probably averaged about the same as that in 1947, with about 230 million board feet of surplus growth each year.

Because of the surplus of net growth over drain, the over-all volume of saw-timber growing stock in the state has increased substantially during the past two or three decades.

Future Growth-Drain Balance

Looking ahead, it appears likely that the volume of growing stock in Illinois, and therefore the annual volume of net growth, will continue to increase each year. As already mentioned, net growth during 1947 amounted to about 4 percent (397 million board feet) of the inventory volume at the beginning of the year, and exceeded the cutting drain by 234 million board feet. Because of this excess of net growth over drain, the volume of growing stock was larger in 1948 than in 1947. At the same rate of growth, the volume of net growth in 1948 was 406 million board feet. Assuming the drain to be about the same in 1948 as in 1947, this net growth represents an increase of 2.3 percent over the 1947 volume that is entirely due to the increase in the volume of growing stock. Thus a surplus of growth over drain increases the volume of growing stock, and this in turn increases the volume of net growth even though the rate of growth remains the same. Rate of growth can be further increased through better forest protection and improved forest management practices.

To reach optimum stocking, more is needed than a mere increase in the volume of growing stock through a continuous surplus of growth over drain. The growth must be concentrated on desirable trees. To accomplish this, improvement cuts must be made to remove undesirable trees and thus make room for increased quality growth and reproduction.

The growth-drain balance in the future obviously will depend largely upon the volume of future cutting drain. But how great this drain should be and how long it will take to build up the Illinois timber stands to optimum stocking are questions that cannot be answered definitely.

If no cutting were done and the present 4 percent rate of net growth were maintained, the present stand of 2,603 board feet per acre could be built up to an average optimum stocking of about 7,500 board feet per acre in about 27 years. On the other hand, since the present drain amounts to only 41 percent of the net growth, the present stand could sustain indefinitely an annual harvest of more than twice the present volume — if the cut were properly distributed among localities and among trees of all species, sizes, and quality. However, without improved management practices, this rate of cutting could never be increased on a sustained-yield basis. The desirable course lies somewhere between these two extremes. A severe reduction in the present annual harvest with the resultant losses in income and employment is neither necessary nor desirable.

The timber harvest can be increased while the forests are being built up. In fact large quantities of low-grade timber and the mature high-quality timber must be marketed to make room for young, thrifty trees to develop. The harvest must be restricted enough, however, to assure a substantial annual surplus of high-quality growth.

Any lag in the expansion of wood-using industries will result in larger surpluses of growth and thus shorten the time required to build up the desired volume of growing stock. On the other hand, some marketing and wood-manufacturing facilities should be developed along with forest development in order to make efficient utilization of the increasing volume that must be cut and to assure adequate markets when the forest reaches full productivity.

The potentialities for industries using low-grade timber are indicated by the fact that net growth of grade 3 logs in 1947 was about 300 million board feet while cutting drain was only about 93 million board feet. Also, in addition to the growing stock, the Illinois forest contains more than 500 million cubic feet (the equivalent of more than 3 billion board feet) of sound wood in cull trees as well as 1 billion cubic feet of sound wood in tops and limbs of saw-timber trees. Any measures to increase the use of such materials should be encouraged.

With regard to high-quality drain, the picture changes considerably. In the Southern region no increase in the cut of high-quality logs can apparently be made now without detrimental effects on the forest

growing stock. In fact, high-quality growth is now being overcut. Whenever feasible, low-quality logs should be substituted for the grade 1 and 2 logs and for the better young trees now being used that may eventually produce high-quality logs.

In the northern two regions some increase in high-quality drain could be made. If the need for additional income or work, or for forest products, becomes great enough, grade 1 and 2 log drain, properly distributed, probably could be increased by as much as one-fourth. This, however, would leave little surplus of high-quality growth with which to improve the growing stock and thus ultimately increase the returns from the forest lands.

A PROGRAM TO INCREASE RETURNS FROM FOREST LANDS

The forest area in Illinois, which now totals about 4 million acres, will probably increase in the future. To be sure, some areas now in forest will be permanently cleared through overgrazing and cutting. However, as land management improves, this kind of clearing will probably be more than offset by the restoration of forest cover on submarginal open lands. Soils technicians, agronomists, and land-use planners familiar with Illinois conditions generally agree that a relatively large acreage of nonforest land, primarily areas of low soil productivity, uncultivated bottomlands, and denuded steep slopes, should be devoted to forestry.

Although many excellent timber stands can be found in the state, the present stands on much of the forest area are in poor condition. The stands on more than 40 percent of the forest area contain less than 1,000 board feet per acre. The present saw-timber volume on the forest area averages probably no more than one-third of the desirable volume. On much of the forest area, high grading, premature cutting, and burning have seriously reduced the quality of the timber, as well as the volume. Grazing has severely damaged or destroyed the understory of tree reproduction in many areas, especially in the Prairie region. Unmerchantable cull trees occupy about one-fifth of the forest growing space. Approximately one-fourth of the gross board-foot volume in all saw-timber-sized trees is cull material. Less than one-fourth of the merchantable saw-timber volume is in logs of grades 1 and 2, from which are produced the quality materials in greatest demand. Much of the merchantable volume consists of the less desirable species.

Although the forests have suffered from mistreatment, the species composition, stocking, and quality of the present stands are sufficient to insure much greater productivity in response to good management. Something must be done if we are to get all the social and economic benefits that the forest resource can provide. Responsibility for action rests jointly upon the landowners, industry, and the local, state, and federal governments. All will share in the increased benefits.

The results of the Forest Survey point to broad remedial measures needed. These results indicate that any adequate forest program should include measures to (1) protect the forest, (2) build up the timber stand, (3) improve marketing, harvesting, and utilization, and (4) intensify research.

Protect the Forest

Without adequate protection from damage by grazing, fire, insects, and diseases, the Illinois forest lands can never reach maximum productivity. Although losses due to these agencies have constantly been reduced during recent years, greater improvement is needed.

Eliminate grazing by domestic livestock. In the Illinois woodlands, grazing is incompatible with maximum timber production. Even when grazing is well-managed, the losses in timber values resulting from grazing damage in farm woodlands far exceed the financial gains from the forage. Furthermore, unless the forest canopy is opened up to provide more light, the woodland forage produced is of little value. Studies conducted in the Central States have shown that forage produced on woodlands with a fairly heavy canopy is inferior to that on cleared pasture both in quantity and in nutritional value. Livestock on such woodland forage not only fail to gain weight, but often lose weight.

Many woodland areas throughout the state are being deliberately overgrazed, cut, and burned to convert them to cropland or pasture. This may be good land management on relatively level sites of high soil productivity. However, many of the areas being cleared are of low productivity or are on steep slopes that are not suitable for agricultural uses. This clearing of nonagricultural land for cultivation or pasture has resulted from the high demand for farm produce during recent years. If the demand for cultivated crops should decrease, many areas now under cultivation will probably revert to pasture. In addition an increasing amount of forage is already being produced in farm crop rotations. With this increased forage production, much poor land

now in unimproved pasture can be reforested and land still in trees need not be grazed.

Each farmer should decide on the most profitable use of his woodland. If timber production is desired, livestock should be kept out. If the need for additional forage is greater than for forest products, the woodland, if suitable for such use, should be converted to improved pasture. In all cases erosion must be considered. Badly eroded areas and slopes too steep to be held in place by other types of vegetation should be restored to and kept under forest cover, and should be protected from livestock.

Intensify fire-control activities. Forest fires destroy tree reproduction. They retard tree growth and increase the volume of cull. Recreational values are reduced and wildlife is destroyed or driven from the area. In addition, fires lower soil productivity and damage watersheds by reducing the water-holding capacity of the soil and thus increasing the likelihood of erosion and floods. This is also true on the nonforested grasslands, particularly in the southern part of the state.

Fire hazard is generally lower in the Illinois woodlands than in many other states because of the scattered pattern of most of the timber stands, the absence of heavy logging slashings, the species composition of the forest (almost entirely hardwoods), and a generally adequate volume and distribution of rainfall.

Fire losses have been reduced in recent years through the efforts of the Illinois Department of Conservation and the Forest Service, U. S. Department of Agriculture. About 2.7 million acres of state and private forest lands in 42 southern counties are included in six fire-control districts given intensive organized protection under a program jointly sponsored by the state and federal governments. In addition, almost 250,000 acres of federal and private forest lands within the boundaries of the Shawnee National Forest are given intensive organized protection by the National Forest organization. The remaining 1.1 million acres of forest land consist primarily of small farmer-owned stands scattered throughout the northern half of the state. Intensive public protection is not considered necessary for these scattered stands since they can be adequately protected by the owners. For these areas, public assistance in fire control is limited to educational activities to gain the support of the woodland owners in a volunteer fire-control program.

In spite of the comparatively low natural hazard and the increased protection, fires still reduce the productivity of 10,000 to 20,000 acres

of forest land each year. During 1949, according to the Division of Cooperative Forest Protection of the U. S. Forest Service, forest fires burned almost 18,000 acres of forest and critical nonforested watershed areas in Illinois.

The annual burn of protected areas in Illinois now averages 0.4 to 0.5 percent. The goal for basic minimum protection is an annual burn of less than 0.3 percent of the protected area. Obviously, improved fire control is needed. This can probably best be accomplished by an intensified program of education.

Reduce insect and disease losses. This can be done by providing for prompt discovery and control of outbreaks, and by cutting and using infected timber while it is still merchantable.

Insects and diseases have never caused spectacular timber losses in Illinois such as those caused by the larch sawfly epidemic in the northern lake states, the chestnut blight in the East, or the various beetle infestations in the West. However, they do cause a steady drain upon the Illinois forests by destroying timber, by reducing growth, and by increasing cull. A number of insects such as the tip moths, budworms, and various wood borers, of which the locust borer probably is the most destructive, are found in the state. Several tree diseases in Illinois and the surrounding states, such as the Dutch elm disease, the much-publicized oak wilt, and phloem necrosis, are causing foresters and some timber operators considerable concern, although the damage to date has been light. The greatest losses in Illinois timber are caused by various wood-rotting fungi that enter trees through fire scars or broken branch stubs and cause stem defects and decay of heartwood.

Build Up the Timber Stand

The greatest opportunities for increasing the returns from the Illinois forest land obviously lie in measures that will build up the stocking and improve the species, size, and quality composition of the timber stand. Several steps may be taken to accomplish these things.

Increase volume of forest growing stock. Since the present growth-drain balance in Illinois is favorable, the forest growing stock is even now being gradually built up. This process can be accelerated in three possible ways: (1) by temporarily reducing the annual harvest; (2) by increasing the rate, quality, and volume of growth through improvement cuts and protection from grazing and fire damage, or (3) by a combination of the first two methods.

Theoretically, if there were no economic considerations, the first

method would most promptly increase the volume of growing stock. A reduction in the volume of annual harvest would, however, bring undesirable losses in employment and local income.

The second of the three methods is the most practical way to increase growth and still satisfy demand. Through improvement cuts and protective measures, the timber stocking can be built up to possibly three times the present volume without reducing the annual harvest. In fact, the annual cut could even be increased, *provided* the cut was properly distributed by locality, species, tree size, and quality. For example, the annual cut could be greatly increased with benefit to the stand if some economical way could be found for removing the cull and low-quality trees.

Improve quality of the timber stands. This can be done by removing cull trees to make more room for thrifty, merchantable growth and by concentrating cutting on low-quality trees whenever possible.

Forest productivity is limited by the large number of cull trees in the present stand. The gross volume in cull trees makes up about one-fifth of the gross saw-timber volume in all saw-timber-sized trees. This unfavorable condition is the result of past cutting practices and of damage caused by grazing, fire, insects, and diseases. Improved protection will reduce the amount of cull in future stands, but obviously cannot remedy the damage already done to the present stand. The only apparent solution to this problem is to harvest the cull trees or to kill them by girdling or poisoning. These cull trees contain more than half a billion cubic feet of sound wood. However, the fact that harvesting and processing gnarled or partially rotten cull trees is not profitable discourages their use. Until profitable methods of harvesting, processing, and marketing trees which are now cull are developed, they will not be removed. Therefore, unless the culls are girdled or poisoned, the future stand will not be as good as it could be.

The common practice of removing the highest-quality trees of favored species has reduced the over-all quality of the Illinois stands. Especially in hardwoods, large trees are required to produce top-quality materials; as a rule, only trees 17 inches d.b.h. and larger can produce hardwood logs large enough to qualify as grade 1. Because large logs generally cost less per unit of product to log and mill, and produce a greater proportion of high-quality materials, they usually return greater profits than do small logs.

Efforts should be made to gradually increase the proportion of large trees in the stand as well as to improve the general quality and species composition. This can be done by cutting practices that favor

the desired species, that leave enough thrifty seed-bearing trees to provide for regeneration and for future cuts, and that remove as high a proportion as possible of the slow-growing trees and trees of poor form and quality. The removal of such trees through harvest or improvement cuttings is probably the most beneficial single measure for improving the Illinois forest.

Expand planting program. Planting is not necessary on the 3 million acres of commercial forest land having good or fair present stocking. Barring grazing, and assuming a reasonable degree of forest management and fire control, the stocking on these woodlands can be improved without planting. The same might possibly be said for the 800,000 acres of poorly stocked forest land. However, to hasten the restoration of these lands and to provide watershed benefits, planting may be justified on as much as a quarter of this area.

By far the greatest need for forest planting is on some 3 million acres of marginal and submarginal agricultural land that, according to the soil-productivity ratings of the Illinois Soil Survey, can be classified as potential forest land. Some of this area has already been abandoned; the rest, although marginal, is still producing cultivated crops or forage, but may be abandoned through gradual changes in the land-use pattern. Although many of these areas originally supported hardwood forests, heavy cropping and soil erosion have so reduced soil productivity that the immediate re-establishment of a satisfactory hardwood forest is seldom possible. A number of pine species, when planted on such eroded land, are able to grow, produce a useful crop of timber, and in the process build up the soil and provide watershed benefits. Once the soil productivity has been sufficiently restored, the hardwoods will work into the stand and, at least on the better sites, will eventually replace the pine.

The planting of this 3 million acres is a tremendous job, one requiring 500 years at the current rate of planting. Much of this land will probably never be planted because many open areas will stock themselves naturally with such "nurse species" as sassafras and persimmon. These will build up the soil in much the same manner as the pine species, and ultimately an acceptable hardwood stand can be expected to develop. Unfortunately, this natural process requires a relatively long time. However, a combination of planting and natural reforestation will speed up the stocking of marginal and submarginal land. Some of this area may, of course, be converted to improved permanent pasture or similar use.

At present, forest planting stock is available to landowners at less

than cost from nurseries of the Illinois Department of Conservation. Federal financial aid to help operate these nurseries is given the state through the provisions of the Clarke-McNary Act. During 1949 the two state nurseries distributed about 5 million trees, enough to plant about 5,000 acres of open land. Practically all of this planting was done by private individuals with little expenditure of public funds. The present planting program is limited by present forest nursery capacity. According to the State Forester, the demand for planting stock is two to three times the supply. It would therefore seem desirable to provide enough forest planting stock to meet the demand. Thus, with a very small expenditure of public funds, the planting program could be more than doubled.

Improve Marketing and Utilization

Maximum returns cannot be obtained from the forest land through good forest management and protection alone. Forest products must be efficiently marketed and utilized to return maximum profits to the timber producers and processors, to provide maximum employment, and to meet most fully the state's requirements for timber products. Increased returns to landowners and timber operators through improvements in marketing and utilization practices will stimulate interest in the woodlands. This in turn will probably result in better management.

Better marketing practices and markets can be developed by intensifying the program of education and demonstration, by developing group marketing facilities, and by expanding local wood-remanufacturing industries. Utilization of waste and low-grade woods can be increased by the development of new uses, of improved equipment, and of more efficient operating methods.

Intensify program of education and demonstration. The failure of Illinois landowners to realize full value for their forest products is often due to their lack of interest and of knowledge, as well as to a lack of adequate marketing facilities. Most of the woodlands are owned by farmers who generally are so busy with their other farming activities that they give little thought to woodland management and to the marketing of their forest products.

One frequent result of this lack of interest, and of knowledge concerning proper marketing practices is the "lump sum" sale of all trees on a specified area. Such sales seldom return full value, and usually result in what is virtually a clear-cutting operation of the larger

trees. Since the buyer has paid for the entire stand, he harvests everything that he thinks will cover the cost of harvesting. What is left will return nothing to the owner for many years. Naturally he then has even less interest in the stand.

Another result of the producers' lack of knowledge about marketing is that they often sell good-quality timber for purposes that could be met by lower-quality materials. The return, although a fair value for the purpose intended by the buyer, is often less than if timber were marketed by grade for its highest use. To get the greatest return for his forest products, the owner must know their value based on the highest use permitted by marketing conditions in the area.

Through years of lump-sum sales and high-grading the over-all quality of Illinois logs has been lowered. Often the quality of the lumber is further reduced by poor milling. Almost two-thirds of all lumber produced in the state is sawn by small portable mills, each of which cuts less than half a million board feet annually. Largely because of faulty equipment, poor set-ups, and lack of skill, much of the lumber produced by these mills fails to meet the quality standards of the imported lumber. Because local lumber is often of poor quality, Illinois industries are reluctant to use it. Thus, even though Illinois consumes 10 to 20 times as much wood as it produces, many timber producers are unable to find suitable markets for their products.

Localized, personal instruction and demonstration for the landowners and sawmill operators would help to improve the quality of Illinois lumber and thus expand the market for it. Landowners also need help in channeling the timber harvested into products for which it is best suited. Since the availability of markets varies in different localities, marketing aid can best be provided by someone familiar with local conditions. A good start in this direction has already been made. The foresters and county farm advisers of the State Extension Service provide some assistance. In addition, the forestry program jointly sponsored by the state and federal governments under the Cooperative Forest Management Act of 1950, aids farm and nonfarm woodland owners and sawmill operators. Technical assistance is given in woodland management and marketing and in sawmill operations.

Develop group marketing facilities. Lack of concentrated volume due to the small size of individual holdings is another serious handicap that limits the sale of local forest products. Industries that require large volumes of raw materials prefer to meet their requirements through a few large suppliers rather than many small concerns. There is a definite need for some form of group marketing, such as concen-

tration yards, to assemble the small quantities of various forest products from the farm woodlands, to finish and grade these products, and to stabilize sources of supply. These objectives possibly could be accomplished through cooperative marketing associations. The cooperative, by assembling the output of several producers, can also build up volumes of specialty materials that will attract buyers paying premium prices. To date, experience with forest cooperatives has been rather limited. They face many difficulties, especially in areas containing depleted forest stands, but if successful, they can benefit both industry and the small woodland owners.

Expand local wood-remanufacturing industries. The development of new secondary wood-manufacturing industries in the more heavily forested sections of the state is another possible means of providing better markets for local timber by grade and species. For lack of such markets many timber owners and operators now process high-quality timber suitable for premium products into common lumber or other less valuable commodities. An increase in the number of local wood-remanufacturing plants would create markets for timber of varying quality specifications, would encourage integrated harvesting and more efficient utilization of the timber, and thus would increase the profits of the timber owners and operators.

Develop new uses for waste and low-grade woods. As already mentioned (page 76), the Illinois forest can never produce maximum returns until the cull and badly defective trees are removed and replaced by trees of desirable species and quality. Relatively little progress in removing these trees can be made until uses for them are developed that will pay the cost — or most of the cost — of removing the cull trees.

Some increase could be made in the use of cull trees for such low-quality products as fuelwood, charcoal, mine timbers, and rough construction lumber. Although this would help, it alone cannot solve the problem. The volume of waste and low-grade wood available is much greater than can be used for such purposes. New uses that will absorb large quantities of such materials are needed.

During recent years some progress has been made in developing new uses for waste and low-grade woods. For example, the roofing-felt industry now uses large quantities of wood chips in place of the rags formerly used in making various roofing and insulating felts. Lumber shortages during and following the war forced many industries to substitute successfully woods of lower grade and inferior species for the

quality materials formerly considered essential. The furniture industry, for example, has substituted less valuable species, such as gum and soft maple, for some of the more valuable woods used a decade or two ago. With the increased use of veneers, the lower-quality woods are being used for veneer core stock. One thing which has boosted the use of these woods has been the development of new, improved adhesives which will join together small sections of wood cut from low-quality timber.

The Forest Products Laboratory at Madison, Wisconsin, and a number of other research organizations, including the Illinois Agricultural Experiment Station, are now experimenting with wood molasses as a livestock and poultry feed supplement. Wood molasses can be made from waste and low-grade woods.

Pulpwood offers one of the most promising outlets for low-grade hardwoods. The volume of wood pulp used for innumerable paper and fiberboard products has been constantly increasing. The upland hardwoods, such as the oak-hickory stands in Illinois, offer a new source of fiber to meet the growing demand for pulp. To date, little use has been made of such species because the pulp industries prefer softwoods and the softer bottomland hardwoods. Bottomland hardwoods, primarily cottonwood and willow, are used to make book and printing papers other than newsprint. The higher-density upland hardwoods are being used to a limited extent for certain products such as corrugating board for shipping containers and for various insulating boards and felts. Further technical developments in this field might create a market for large quantities of waste and low-grade hardwoods which would greatly affect future management practices in the hardwood forests of Illinois as well as elsewhere.

Improve harvesting equipment and operating methods. New, relatively inexpensive mechanical harvesting equipment and methods adapted to the small woodland could contribute greatly to silviculture, management, and income. In general, the need is for inexpensive attachments that can be used on farm tractors or other farm units. These would enable farmers to do their own logging without large investments for logging equipment. They then could afford to cut more low-grade trees.

The use of sulkies or other devices to reduce friction would increase the efficiency of farm tractors on skidding operations. Falling and bucking operations could be improved through greater use of chain saws on large timber and of bow saws on small timber cut for mine timbers, fence posts, or fuelwood. Loading costs could probably be

reduced through the use of self-loading trucks or of inexpensive loaders powered by the farm tractor. By bundling timbers into unit packages, handling costs could be reduced on some operations harvesting small timber for products such as mine props or pulpwood. A reduction in logging and handling costs will permit increased use of inferior woods. Increased utilization of such materials will improve the composition of the forest and conserve the better-quality materials for higher use.

Intensify Research

Before Illinois' forest lands can be built up to maximum productivity and be made to provide maximum benefits for the people of the state, many problems must be solved through research. Without adequate research, many costly errors will be made and much valuable time and effort lost. A complete and detailed list of the many problems requiring investigation cannot be presented here, but those which should be given special attention are included in the following broad phases of needed research:

1. Development of a land classification system to determine the best ultimate use of all land and the specific areas best suited to forest use.

2. Correlation of timber, recreation, wildlife, and watershed uses on forest land to return the greatest over-all benefits through multiple use.

3. Determination of the most efficient methods of planting and plantation management with special emphasis on means of reducing costs.

4. Determination of the most efficient means of protecting the forest from grazing, fire, insects, and diseases, and of the extent of protection needed.

5. Determination of the most efficient methods of rehabilitating and managing hardwood stands under various site conditions and for the production of various products.

6. Development of more efficient equipment and operating methods for harvesting and processing forest products that will reduce waste and labor costs and thus improve the competitive position of the Illinois operators.

7. Development of new uses and markets for low-grade woods, and investigations leading to the greatest possible substitution of local timber for forest products now imported.

Forest research is being carried on to a limited extent in many parts of the nation by a number of large industrial corporations, privately endowed foundations, and trade associations. In Illinois, where small landowners and small forest-products industries predominate, forest research is largely a public responsibility. Publicly financed forest research is conducted in Illinois by the University of Illinois Agricultural Experiment Station, the Southern Illinois University, and the research units of the Forest Service, U. S. Department of Agriculture. Of the latter, the Forest Products Laboratory and the Central States Forest Experiment Station, through its Research Center at Carbondale, Illinois, are helping to solve Illinois' forest problems.

Although many problems are still to be solved by careful experimentation and investigation, much unapplied information is already available. The knowledge gained through experience and research is of little value unless it is used to improve existing conditions. Many measures already known to be beneficial can be applied without delay. Broader application of existing knowledge and immediate application of new research findings can reduce the time required to restore the Illinois forest resources to full productivity.

SUMMARY

Illinois is one of the leading industrial and agricultural states in the nation. The Illinois forests, although very important in some localities, play a minor role in the over-all economy of the state. Although the state is a leader in the production of wooden products, 90 to 95 percent of the wood used is imported from other states. Roughly three-fourths of the wood consumed in Illinois is of softwood species which must be imported because the local forests contain practically no softwoods. The state also imports 70 to 75 percent of its hardwood requirements, all of which, except for a small volume of specialty woods, could be produced locally.

The Illinois forests could be built up to provide a sustained annual harvest of possibly seven times the present cut, far more than the state's present hardwood requirements. Forest restoration would also have a beneficial influence on water supplies, erosion control, game and fish, and recreation. Although progress in restoring the forest to maximum productivity is slow, it can be greatly accelerated. Improved forest management and utilization can greatly increase the volume and quality of growing stock, the volume and quality of growth, and ultimately the benefits derived from Illinois' forest lands.

Forests now occupy 11 percent of the total land area. The forest area in Illinois totals about 4 million acres. All but 55,000 acres of it is classified as commercial forest land. The proportion of land in forest is highest in the Southern region — 26 percent as compared to 16 percent in the Claypan region and 7 percent in the Prairie region. The most extensive forests in the state are located on the Ozark hills in the Southern region and on the rough breaks and bottomlands along the major streams. Smaller forest tracts are scattered throughout the state in thousands of farm woodlands.

The oak-hickory forest type occurs on nearly half of the forest area and predominates in the upland areas throughout the state. The bottomland hardwood type occurs on about one-fifth of the forest area and is rather uniformly represented in all regions. The mixed hardwood type and the white oak type are more prevalent in the north than in the south. The pin-oak flats are largely confined to poorly drained areas in the two southern regions.

Saw-timber stands occupy 1.8 million acres or 46 percent of the commercial forest land. More than two-thirds of the saw-timber area contains enough volume in trees 15 inches d.b.h. and larger to be classed as large saw-timber area. Pole-timber stands occupy 25 percent of the commercial forest area; seedling and sapling areas make up 19 percent; and nonstocked areas, 10 percent.

About 95 percent of commercial forest land is privately owned. Nearly all of it is in small tracts owned by farmers. Federal holdings total 179,000 acres, of which 147,000 acres are located in the Shawnee National Forest in the Southern region. About 2,000 acres of federal forest land has been withdrawn from timber production. The state owns about 10,000 acres of commercial forest land as well as an additional 18,000 acres of forest land that has been withdrawn from commercial timber production for use as state parks and wildlife refuges. All of the 26,000 acres of forest land owned by counties and municipalities have been withdrawn, chiefly for recreational use and the protection of reservoir watersheds. Because of the ownership pattern, it is apparent that the future of the state's forest resources depends largely on the management given the small, privately owned woodlands.

The commercial forest land supports more than 10 billion board feet of saw timber. The oak species combined make up 56 percent of the total volume, white oak alone accounting for 20 percent, and black oak and northern red oak each making up about 10 percent. Other common species are elm, hickory, and soft maple. Softwood species are of minor importance throughout the state.

Less than one-fourth of the saw-timber volume is in grade 1 and 2 logs (approximately 8 percent in grade 1), from which are obtained most of the quality materials required by the cooperage, veneer, and furniture industries. Measures to increase the proportion of high-quality timber in the Illinois forest should be given high priority in the forest management program.

The volume of total growing stock, saw timber and pole timber combined, totals 2.4 billion cubic feet. One-third of the total is in pole-timber trees.

Much of the forest land is occupied by cull trees. Almost one-fifth of the gross board-foot volume in all trees of saw-timber size is in cull trees. Practically none of this volume is merchantable under present marketing standards. Considering only the saw-timber trees, those with enough sound volume to be merchantable, approximately 7 percent of the gross board-foot volume is cull material. One of the major problems in the forest program is the removal of cull trees to make room for trees of better quality.

Illinois' forest-products industries provided over 46,000 man-years of employment during 1947. Of this total, the wood-remanufacturing industries in the state provided more than 41,000 man-years. These industries now depend largely on imported wood.

Almost 5,000 man-years of Illinois labor were expended during 1947 to produce roughly 52 million cubic feet of primary forest products. These products — rough logs, bolts, and billets — were valued at more than 12 million dollars. Further processing added considerably more to their final value. Almost three-fourths of the total volume consisted of sawlogs and fuelwood; fence posts accounted for about 9 percent; and the remaining 17 percent was made up mainly of tight cooperage stock, pulpwood, veneer logs, and mine timbers.

Annual cutting drain amounts to 163 million board feet. The 1947 cutting drain on the saw-timber growing stock for forest products totaled 163 million board feet. Roughly two-thirds of this saw-timber volume was cut for lumber, 13 percent for cooperage, and the remaining 21 percent for other products, chiefly veneer and fuelwood. The 1947 cutting drain on the total growing stock totaled 38 million cubic feet.

The volume of timber in Illinois is increasing. During 1947 the volume of saw-timber growing stock increased 2.3 percent or 234 million board feet. The total growing stock increased 2.3 percent or 52 million cubic feet. For the state as a whole, the saw-timber cutting

drain amounted to only 41 percent of the net growth. Cutting drain was heaviest in the Southern region, which contained 25 percent of all saw-timber growing stock and supported roughly 35 percent of the 1947 saw-timber cutting drain in the state. In the Southern region, the 1947 cutting drain amounted to 56 percent of the saw-timber net growth.

Quality must be considered in growth-drain comparisons. Under prevailing cutting practices in Illinois the drain is concentrated on trees of favored species and better than average quality. Growth, on the other hand, is distributed over trees of all species, sizes, and quality — including the less desirable ones. As a result, stand deterioration occurs in many areas despite the very favorable growth-drain balance for the entire state.

The drain on logs of grades 1 and 2 during 1947 amounted to nearly three-fourths of the high-quality saw-timber net growth. High-quality saw-timber growth was seriously overcut in many localities of the Southern region and was overcut about 30 percent in the region as a whole. The deficit of quality growth in this region was more than offset by a surplus of quality growth in the northern two regions, especially in the agricultural Prairie region. There cutting is less intensive because the forest areas are small and scattered, because the more prosperous landowners often prefer to keep their timber, and because many landowners are too busily engaged in other agricultural pursuits to give much attention to their woodlands.

Annual timber harvest can be increased substantially. Throughout the state the annual harvest of low-quality logs could be increased immediately if markets were available or could be developed. The growth of grade 3 saw timber during 1947 is estimated at about 300 million board feet as compared with an estimated 93 million board feet of grade 3 saw-timber drain. In addition to the growing stock of 2.4 billion cubic feet, the Illinois forests contain more than 500 million cubic feet of sound wood in cull trees and 1 billion cubic feet in unmerchantable tops and limbs. Any measures that will increase the use of low-grade materials should be encouraged.

The situation with regard to high-quality logs is different. In the Southern region high-quality drain cannot be increased now without harming the forest growing stock. In the northern two regions the annual harvest of high-quality logs could be increased by as much as one-fourth, although any appreciable increase will lengthen the time required to build up the forest to maximum productivity.

The present volume of annual growth in Illinois is low primarily because the volume of growing stock is low. The time required to build up the forest to maximum productivity depends upon the volume of surplus growth allowed to accumulate each year and upon proper improvement cutting to increase the volume of growth on desirable trees. The volume of growing stock might be built up to provide two to three times the present volume of growth. At such a level of productivity the Illinois forest lands could provide a sustained annual harvest of seven times the volume cut during 1947 and support a greatly expanded forest-products industry.

Something must be done if we are to get all the benefits that Illinois forest land can provide. Unlike some other resources, the forest resource is renewable. The Illinois forest lands can be restored to full productivity. Responsibility for action rests jointly upon the landowners, industry, and the local, state, and federal governments, all of whom will share the increased benefits.

The results of the Forest Survey point to a number of broad remedial measures needed if the contributions of the forest land are to be appreciably increased. Any adequate forest program in Illinois should include measures to (1) protect the forest, primarily from livestock and fire, (2) build up the stocking and improve the composition of the timber stand, (3) improve timber marketing and utilization, and (4) intensify research to determine the most efficient methods of managing, harvesting, and utilizing the Illinois forest.

APPENDIX

Forest Survey Procedure

Inventory

The inventory work of the Forest Survey of Illinois was begun in October, 1947, and was completed in May, 1948. A sampling procedure was used involving an office study of aerial photographs taken for the most part in 1939 and 1940, and a field examination of randomly selected forest and nonforest plots.

The proportion of forest land by counties was obtained by placing over each photograph a transparent template marked with uniformly spaced dots and by counting the number of dots falling on forest and on nonforest areas. The percentage of forest dots in a county applied to the total land area gave a preliminary estimate of the forest acreage.

The locations of a selected number of dots falling on forest land were marked on the photograph. The acre surrounding each marked dot was examined under stereoscope and classified by stand-size class on the basis of the height, crown width, and density of crown cover on the plot.

Plots for field examination were selected from those photo-classified as follows:

Saw-timber areas	1 in 4
Pole-timber areas	1 in 8
Seedling and sapling areas	1 in 16
Poorly stocked areas	1 in 8

In addition, every 50th nonforest plot was selected for field examination to measure the movement of nonforest land to forest.

The locations of the selected plots were marked on the photographs, which were then sent to the field. Crews of two men each located these points on the ground and at each established a 1/5-acre plot on which they recorded the number of trees by species, size, and condition; the growth rate of trees; and the forest type and site quality of plots. A field check of the photo interpreter's stand-size class determination was also made. In addition, the field examination provided a basis for adjusting the preliminary estimate of forest and nonforest area.

Approximately 191,350 dots were counted on the photos for forest-area determination. Stereoscopic examinations to determine stand-size class were made of 5,933 forest plots. Field crews examined 1,033 forest plots and 266 nonforest plots. These photo and field examinations provided the basic data for computing forest area, growth, and timber volume statistics for the state.

Volume tables

The volume tables used in the Illinois Survey were based on the Mesavage-Girard form class tables. Measurements were taken on 767 trees[1] to test the applicability of these tables under Illinois conditions. Sample trees were selected on timbered areas throughout the state. Volumes of these trees were

[1] Members of the Illinois Technical Forestry Association assisted in obtaining these tree measurements.

compared with the Mesavage-Girard volumes by form class, species, diameter, and number of logs. These comparisons proved that the tables could be adapted for use in Illinois.

Gross volume tables for saw-timber trees were prepared by species group, d.b.h., and number of logs. These gross volume tables were based on form class tables derived from a regression equation of form class on d.b.h. and number of logs. Survey field data indicated the appropriate form class for each important species group. Gross volume tables for pole-timber trees were obtained by curving volume over d.b.h. by three species groups based upon merchantable height of trees. Consistent form class measurements cannot be obtained readily from small hardwood trees so no attempt was made to adjust the cubic-foot form class tables to fit these data. Cull factors were applied to the gross volume tables to obtain net volume tables.

Cull

On the field plots, individual trees which did not qualify as saw-timber or pole-timber trees were tallied as culls. The volume in cull trees was not included in the volume of growing stock nor in growth and drain estimates.

The cull factors (percent of gross volume lost because of rot, shake, crook, or other defect) for determining the net volumes of saw-timber and pole-timber trees, and for determining the cubic volume of sound wood in cull trees were based on (**1**) cull estimates made by the field crews on the inventory field plots, (**2**) studies of cull previously made in the region, (**3**) cull data from local foresters and timber operators, and (**4**) cull data from national forest timber sales records. These data were weighted by source and reliability and provided cull factors by species group and tree-diameter class. The cull factors were applied to gross volume tables to obtain net volume tables.

Growth

Growth computations were based upon the measurement of increment cores from 1,972 sample trees on the inventory field plots. Future growth and ingrowth of the sample trees were predicted on the basis of periodic annual growth during the past 10 years. This growth was expressed as a percentage of present sample tree net volume by species and tree-diameter class. Growth, ingrowth, and mortality percentages were applied to inventory volumes to get net volume growth.

Estimates of growth by log grade were based upon the proportion of the inventory volume in each log grade. These inventory log-grade ratios were applied to annual net growth by tree-diameter and species groups. The volume of high-grade (grades 1 and 2) ingrowth in saw-timber trees which were too small to contain high-grade logs at the beginning of the year but grew to sufficient size during the year was added to the high-grade growth of the larger trees. This volume of high-grade annual growth was subtracted from the annual net saw-timber growth to obtain the volume of low-grade (grade 3) annual growth.

Mortality

Mortality, the volume of drain caused by natural agencies, such as fire, insects, and disease, was estimated by a procedure similar to that used for

inventory volume. All dead trees 3.0 inches or larger d.b.h. standing or down, that died within the last four years and that were merchantable at the time of death were tallied on the field plots. The volume removed from the growing stock through mortality was computed from the plot data by the procedure used to determine the merchantable inventory volume.

Cutting drain

Commodity or cutting drain estimates for 1947 were based upon production data obtained from a number of sources. Lumber drain was computed from 1947 lumber production as reported by the Bureau of the Census, U. S. Department of Commerce. This lumber production volume was obtained by a complete census of the Illinois sawmills conducted as a part of the 1947 Census of Manufactures.

Estimates of 1947 fuelwood, fence-post, and miscellaneous farm timber production were based upon the Master Sample of Agriculture, an area-sampling procedure developed at the Iowa State College in cooperation with the U. S. Bureau of the Census and the U. S. Bureau of Agricultural Economics.

The estimate of 1947 production of mine timbers was based upon a sampling of mines stratified by type and production-size class. The total volume of wood consumed was computed by applying the average sample ratio of wood consumed per ton of coal produced to total 1947 coal production as reported by the Illinois Department of Mines and Minerals. Total consumption was allocated by geographic source and class of material through application of factors based on the sample mine data.

Estimates of 1947 production of all other commodities were based upon a complete canvass of producers, concentrators, or processors made by the Forest Survey staff with the cooperation of members of the Illinois Division of Forestry and the Illinois Agricultural Experiment Station. The source of information varied by product to provide fullest coverage at least cost.

Estimates of saw-timber drain by log grade were made for lumber, veneer, handle stock, and tight cooperage — the only forest products for which any appreciable quantities of high-grade (grades 1 and 2) logs are used. The log grade of drain for lumber was based upon a grading of logs totaling 70,278 board feet on 30 randomly selected logging and milling operations. Log grade of drain for container veneer was based upon studies of 13,332 board feet of logs at five mills by C. S. Walters of the University of Illinois Agricultural Experiment Station. All face veneer logs, handle stock, and tight cooperage bolts were assumed to be of log grade 2 or better. Only high-grade logs are used for such products; the low-grade logs cut on integrated operations are generally used for sawlogs or other less valuable products. The sum of these volumes of high-grade log drain was subtracted from the volume of annual saw-timber drain to obtain the volume of annual low-grade (grade 3) log drain.

Computations

Field plot data for estimates of growth, mortality, and timber volume were compiled by use of tabulating machine cards. All data on the field plot sheets were transferred to cards for machine tabulation. Final tables were prepared from the machine tabulations by applying factors which represented

the relationship of the area sampled to the total commercial forest area. This method made possible rapid, accurate compilation of field data at a minimum cost.

Accuracy of Data

Forest area

Statistical analysis of the forest area data for the state of Illinois shows a sampling error of ±1.57 percent of the total forest area or ±63,000 acres, at a level of one standard deviation. The error of estimate increases with each subdivision of the total forest area, so that small acreages may have large errors and therefore indicate only relative magnitudes.

Timber volume

The sampling error of the total board-foot volume in the state is ±3.69 percent or ±380 million board feet. This does not include the errors of volume tables, cull factors, or other phases of the inventory work for which satisfactory methods of measuring accuracy have not been developed. All phases of field work and computations were closely supervised to keep these errors at a minimum. Again, the error of estimate increases with each subdivision of the total volume so that small volumes indicate only relative magnitudes.

Cutting drain

Analysis of the 1947 cutting drain data shows a sampling error of ±7.6 percent of the total drain volume or ±2.9 million cubic feet, at a level of one standard deviation. This is a measure of the sampling error only and is based on the variance or individual deviations of the sample data. It does not include other types of errors such as reporting, canvassing, and compilation errors. Such additional errors were eliminated as far as possible by close supervision of all field work and computations.

Definitions of Terms Used

Forest land classes

Forest land. Land bearing forest growth or land from which the forest has been removed but which shows evidence of past forest occupancy and which is not now in other use. To qualify as forest an area must (1) be at least 100 feet wide; (2) be at least one acre in area; (3) have a sufficient number of trees to provide 10 percent crown coverage; or (4) lacking 10 percent crown coverage, be likely to remain in forest use.

Commercial forest land. Forest land bearing or capable of bearing timber of commercial character, economically available now or prospectively for commercial use, and not withdrawn from such use.

Noncommercial forest land. Forest land not qualifying as commercial forest land. Two classes of forest area are included: (1) commercially valuable forest land withdrawn from timber use for such purposes as parks, game refuges, military reservations, or reservoir sites; and (2) forest land which because of poor growing conditions will not produce trees of commercial quality.

Forest types

Oak-hickory. Stands of hardwoods in which oaks and hickories comprise at least 60 percent of the dominant and codominant trees.

White oak. Stands in which white oak (*Quercus alba*) comprises at least 60 percent of the dominant and codominant trees.

Mixed hardwoods. Stands of mixed hardwood species not qualifying for other hardwood types. Principal species include elm, maple, basswood, and black walnut in mixture with oaks and hickories.

Pin-oak flats. Stands of pin oak and other hardwoods occurring on poorly drained flats. Associate species include elm, hickory, and ash, swamp white oak, bur oak, and other moist-site oaks.

Bottomland hardwoods. Stands on the alluvial bottoms of rivers and streams. The principal species include soft maple, elm, cottonwood, sycamore, hickory, and other hardwoods as well as a relatively small volume of cypress.

Scrub hardwoods. Stands in which noncommercial hardwood species comprise at least 60 percent of the dominant and codominant trees.

Tree classes

Saw-timber trees. Live softwood trees at least 9.0 inches d.b.h. or live hardwood trees of commercial species at least 11.0 inches d.b.h. with a sound butt log at least 8 feet long, or with at least half of the gross volume of the tree in sound material.

Pole-timber trees. Live trees of commercial species at least 5.0 inches d.b.h. but less than saw-timber size, which now are or give promise of becoming merchantable trees.

Seedlings and saplings. Live trees of commercial species less than 5.0 inches d.b.h.

Cull trees. Live trees of commercial species that do not qualify as pole-timber or saw-timber trees because of poor form, limbiness, rot or other defect, and live trees of noncommercial species.

Volume estimates

Net board-foot volume or saw-timber growing stock. Includes the volume of that portion of saw-timber trees merchantable for sawlogs or cross ties (log Grade 3 or better, *see* page 94). Volume deductions have been made for rot, crook, and other defects commonly recognized in board-foot products. Board-foot volumes are shown in the International ¼-inch log rule, which, according to standard lumber association scaling practices, approximates green lumber tally.

Net cubic-foot volume or total growing stock. Includes the volume of sound wood inside bark in (1) the sawlog portion of saw-timber trees, (2) the upper stems of softwood saw-timber trees to a 4.0-inch minimum top diameter inside bark, and (3) pole-timber trees to a 4.0-inch minimum top diameter inside bark. Volume deductions have been made for rot only.

Cubic volume of sound wood. Includes the volume of sound wood inside bark in all living trees 5.0 inches d.b.h. and larger from the stump to a 4.0-inch minimum top diameter inside bark.

Stocking classes

Trees of all size classes, excluding cull trees and trees of noncommercial species, existing on the area were considered in determining stocking. Three degrees of stocking were recognized on the basis of percent of ground area covered by the crowns of trees of commercial species:

Good stocking. 70 percent or better crown cover.

Fair stocking. 40 to 70 percent crown cover.

Poor stocking. Less than 40 percent crown cover.

Site classes

The average number of 16-foot merchantable logs produced by mature trees determined the site class. All stem sections ½ log or longer, suitable for cross ties or rough lumber, were considered to be merchantable. Merchantable heights were estimated to the nearest one-half log. Where mature trees were not present, site was estimated from soil and moisture conditions, topography, exposure, and appearance of vegetation. The following sites were recognized:

Very good sites. Areas producing hardwood trees that average 3 logs or better at maturity.

Good sites. Areas producing hardwood trees that average 2 and 2½ logs at maturity.

Fair sites. Areas producing hardwood trees that average 1 and 1½ logs at maturity.

Poor sites. Areas producing hardwood trees that average ½ log at maturity.

Stand-size classes

Large saw timber. Stands having a minimum net volume of 1,500 board feet per acre in saw-timber trees with more than 50 percent of the net board-foot volume in trees 15.0 inches d.b.h. or larger.

Small saw timber. Stands having a minimum net volume of 1,500 board feet per acre in saw-timber trees with 50 percent or less of the net board-foot volume in trees 15.0 inches d.b.h. or larger.

Pole timber. Stands having a net volume of less than 1,500 board feet per acre, but which are at least 10 percent stocked (30 stems per acre) with live pole-sized and larger trees of commercial species, of which at least one-half are of pole size.

Seedling and sapling. Stands not qualifying either for saw timber or pole timber but which are at least 40 percent stocked (300 stems per acre) with seedlings and saplings.

Nonstocked. Commercial forest land, including denuded forest area, not qualifying for any other class.

Diameter measurements

Diameter at breast height (d.b.h.). Tree diameter, outside of bark, measured at 4.5 feet above average ground level.

Diameter class. Trees were recorded in 2-inch diameter classes, each class including diameters 1.0 inch below and 0.9 inch above the midpoint of the class; e.g., the 8-inch class included all trees ranging from 7.0 to 8.9 inches d.b.h.

Diameter inside bark (d.i.b.). Tree diameter, inside of bark, at point specified.

Hardwood log grades

Grade 1. Logs with top diameters of at least 14 inches inside bark and with five-sixths of the surface on the three best faces clear of defect in not more than two cuttings. Lumber yield from such logs will normally average 65 percent No. 1 common and better.

Grade 2. Logs with top diameters of at least 12 inches inside bark and with two-thirds of the surface on the three best faces clear of defect in not more than three cuttings. Lumber yield from such logs will normally average 40 percent No. 1 common and better.

Grade 3. Merchantable logs with top diameters of at least 8 inches inside bark which do not meet the requirements of higher grades. Such logs will normally average less than 25 percent No. 1 common and better lumber or will be suitable only for ties or timbers.

Growth and drain

Total growth. The annual increase in the volume of growing stock due to growth (before making deductions for mortality losses). This increase includes the volume added through growth on all trees in the growing stock at the beginning of the period, plus the total volume in all trees that during the year reach the minimum diameter for growing stock (ingrowth).

Mortality. The average volume lost annually from the growing stock by the death of the individual trees through such natural causes as fire, insects, disease, drouth, wind, and tree competition.

Net growth. Total growth minus mortality losses.

Saw-timber or board-foot net growth. The net growth on the saw-timber growing stock.

Cubic-foot net growth. The net growth on the total growing stock.

Cutting drain. The volume of material removed from the growing stock for commodity production including both the volume utilized and the volume of growing-stock material cut but not utilized in logging and processing.

Saw-timber or board-foot drain. Cutting drain on the saw-timber growing stock.

Cubic-foot drain. Cutting drain on the total growing stock.

Species listed[1]

Common name	*Botanical name*
Commercial species:	
Redcedar (Eastern redcedar)	*Juniperus virginiana*
Cypress (Baldcypress)	*Taxodium distichum*
White oak	*Quercus alba*
Black oak	*Quercus velutina*
Northern red oak:	
Northern red oak	*Quercus borealis*
Swamp red oak	*Quercus falcata* var. *pagodaefolia*
Post-oak group:	
Post oak	*Quercus stellata*
Swamp white oak	*Quercus bicolor*
Swamp chestnut oak	*Quercus prinus*
Overcup oak	*Quercus lyrata*
Bur oak	*Quercus macrocarpa*
Chinquapin oak	*Quercus muehlenbergii*
Chestnut oak	*Quercus montana*
Other red oaks:	
Southern red oak	*Quercus falcata*
Pin oak	*Quercus palustris*
Scarlet oak	*Quercus coccinea*
Willow oak	*Quercus phellos*
Water oak	*Quercus nigra*
Shingle oak	*Quercus imbricaria*
Elm	*Ulmus* spp.
Hickory	*Carya* spp.
Soft maple:	
Red maple	*Acer rubrum*
Silver maple	*Acer saccharinum*
Boxelder	*Acer negundo*
Sycamore (American sycamore)	*Platanus occidentalis*
Cottonwood (Eastern cottonwood)	*Populus deltoides*
Ash	*Fraxinus* spp.
Sugar maple	*Acer saccharum*
Basswood and yellow-poplar:	
Basswood (American basswood)	*Tilia* spp.
Yellow-poplar	*Liriodendron tulipifera*
Cucumber tree	*Magnolia acuminata*
Black walnut	*Juglans nigra*
Other hardwoods:	
Includes all other commercial hardwood species.	
Noncommercial species:	
Includes species that do not normally have commercial value such as:	
Hawthorn	*Crataegus* spp.
American hornbeam	*Carpinus caroliniana*
Eastern hophornbeam	*Ostrya virginiana*
Alder	*Alnus* spp.
Eastern redbud	*Cercis canadensis*
Service berry	*Amelanchier* spp.

[1] Based on the index of plant names published in "Woody-Plant Seed Manual," U. S. Dept. Agr. Misc. Pub. 654. 1948.

8M—12-52—50445